Coeur d'Alene Tribe
Fish, Water, and Wildlife Program

Fisheries Program Management Plan

Coeur d'Alene Tribe Department of Natural Resources
Fish, Water, and Wildlife Program
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Section 1.0

Coeur d'Alene Tribe Fish, Water and Wildlife Program Management Plan: Enhancement of Resident Fish Resources within the Coeur d'Alene Indian Reservation

1.1 Introduction/Purpose and Need

Fisheries resources are an integral part of the Coeur d' Alene Tribe's cultural heritage. Anadromous and resident salmonids were a critical component of the tribe's annual subsistence requirements. The Coeur d'Alene Tribe, however, lost their salmon fishery with the construction of the Monroe Street Dam in the city of Spokane, and Little Falls Dam farther downstream in the Spokane River. The anadromous fishery was further extirpated by the construction of Chief Joseph and Grand Coulee Dams on the Columbia River. These actions forced the Coeur d'Alene Tribe to rely solely on the resident fish resources of Lake Coeur d'Alene.

Historical evidence suggests that cutthroat trout were an abundant and important resident fishery for the Coeur d'Alene Indians. The Coeur d' Alene's maintained several semi-permanent and permanent fishing camps along the Spokane River near Coeur d'Alene Lake (Peltier, 1975). Peltier (1975) goes on to state that the harvest of large salmon and cutthroat trout in the river, and bull trout from the lake, contributed significantly to their overall subsistence needs. Scholz et al (1985) estimated that in the mid 1800's, Coeur d'Alene Tribal members harvested 210,000 pounds of resident fish and 460,000 pounds of salmon, annually. A traditional fish trap was operated on the Coeur d Alene River for over 50 years until it was inundated by the construction of Post Falls Dam in 1903 (Scott, 1968; and Scholz et. al., 1985). This trap caught thousands of trout and whitefish annually. Successful harvest of resident species continued for many years after that. In 1967, the harvest of fish (total number of fish taken) from Coeur d'Alene lake ranked second only to Pend Oreille Lake (Mallet, 1968). Historically, Coeur d'Alene tribal fishers caught around 42,000 cutthroat per year (Scholz et. al., 1985). In 1967, the cutthroat trout number had dropped dramatically when only 3,329 cutthroat were harvested by tribal and non-tribal anglers on Coeur d'Alene Lake (Mallet, 1968). In recent years, the number of cutthroat returning to spawn was the lowest ever recorded and in some tributaries the runs have vanished.

In 1987, the Northwest Power Planning Council amended the Columbia River Basin Fish and Wildlife Program and recommended that the Bonneville Power Administration (BPA) fund a baseline stream survey of tributaries located on the Coeur d' Alene Indian Reservation and provide recommendations on ways to improve the fisheries for the Coeur d'Alene Tribe. These recommendations were based on the Northwest Power Planning Council adoption of a "substitution policy" which mitigated for losses attributable to anadromous fish losses the Coeur d'Alene Tribe suffered due to the construction and operation of Grand Coulee and Chief Joseph dams.

In 1994, the Northwest Power Planning Council adopted the recommendations set forth by the Coeur d'Alene Tribe to improve the Reservation fishery. These actions included: 1.) Implement habitat restoration and enhancement measures in Lake, Benewah, Evans and Alder creeks; 2.) Purchase critical watershed areas for protection of fisheries habitat; 3.) Conduct an educational/outreach program for the general public within the CDA Reservation to develop a "holistic" watershed protection process; 4.) Develop an interim fishery for tribal and non-tribal members of the reservation through construction, operation and maintenance of trout ponds; 5.) Design, construct, operate, and maintain a trout production facility; and 6) Implement a five-year monitoring program to evaluate the effectiveness of the hatchery and habitat improvement projects.

These recommendations were based on baseline evaluations the Coeur d'Alene Tribe completed between 1991 and 1994, in which twenty tributaries on the Reservations were analyzed and identified as having habitat potentially suitable for trout species. The Missouri method of evaluating stream reaches was subsequently utilized to rank these tributaries, resulting in the identification of four watersheds as having the best potential for enhancing and or restoring cutthroat and bull trout habitat.

During 1991-1995, watershed assessments were completed on the Lake, Benewah, Evans and Alder creek watersheds. These assessments looked at habitat conditions, population dynamics of trout species; habitat utilization, migratory behavior, age, growth and condition, extent and effectiveness of cutthroat and bull trout spawning, and alternatives for restoring cutthroat and bull trout stocks. As part of these assessments, biological objectives were established to provide the basis for developing restoration alternatives, a list of habitat improvement opportunities, and cost estimates for those improvements.

Since 1995, efforts have focused on development and implementation of a long-term fisheries enhancement plan that addresses the following six areas adopted by the Northwest Power Planning Council:

1. Implement habitat restoration and enhancement measures in Lake, Benewah, Evans and Alder creeks.
2. Purchase critical watershed areas for protection of fisheries habitat.
3. Conduct an educational/outreach program for the general public within the CDA Reservation to develop a "holistic" watershed protection process.
4. Develop an interim fishery for tribal and non-tribal members of the reservation through construction, operation and maintenance of trout ponds.
5. Design, construct, operate, and maintain a trout production facility.
6. Implement a five-year monitoring program to evaluate the effectiveness of the hatchery and habitat improvement projects.

Contractual obligations with the Bonneville Power Administration require the Coeur d'Alene Tribe to develop a management plan for the Coeur d'Alene Tribe's resident fish substitution program. This document outlines a management plan which defines a conceptual approach for each proposed action, and provides uniform instructions for the planning, implementation, monitoring, and evaluation of the above actions. An implementation schedule for long-range (five years) planning needs is provided. This document also provides management standards that can be used to direct projects and evaluate program effectiveness. The management plan recognizes that a successful and effective program is one that satisfies program goals and objectives and is adaptable to changing circumstances.

1.2 Program Goals and Objectives

The Bonneville Power Administration under the Northwest Power Act has responsibilities to mitigate for salmon losses due to hydropower facilities. As a result, the Coeur d'Alene Tribe has received resident fish substitution mitigation funding to enhance on-Reservation fishing opportunities through the development of a resident fish substitution program. The Mission Statement for the Fish, Water and Wildlife Program requires the Tribe to "restore, protect, expand, and re-establish fish populations to sustainable levels and provide harvest opportunities for Coeur d'Alene Tribal Members." The Coeur d'Alene Tribe identified two biological goals for their fishery:

1. Restore tributary populations of native fish assemblages; and

2. Increase subsistence harvest.

In order to achieve these goals the following objectives and strategies were identified:

1. Develop and maintain continuous, healthy riparian corridors that support the full range of ecological and hydrological processes;
2. Manage the riparian/aquatic interface for both wildlife and limited domestic use while protecting water quality, public health, and the fisheries resource;
3. Create long-term fishing opportunities for the local community.
4. Re-establish and protect self-sustaining populations of westslope cutthroat and bull trout to the Lake Coeur d'Alene System; and
5. Develop an effective outreach program for support of restoration opportunities

1.3 Document Organization

This document is organized as follows:

Section 1: Introduction. This section describes the purpose and need for this document. It also provides goals and objectives of the BPA fisheries enhancement program.

Section 2: Approach to the Restoration of Fluvial Fish Habitats on the Coeur d'Alene Reservation. This section focuses on the development of a conceptual approach to habitat restoration and provides instructions for planning, implementing, monitoring and evaluating restoration projects.

Section 3: Pond Fisheries. This section focuses on the development of a "put and take" fishery to reduce pressure on wild stocks of fish, hence enhancing the opportunity of the recovery of resident fish population in reservation waters. This section also provides instructions for planning, implementing, monitoring and evaluating these projects.

Section 4: Education/Outreach. This section focuses on the development of a landowner outreach program and the concurrent development of watershed working groups within the project areas. This section outlines a conceptual approach to developing an outreach program and provides instructions for planning, implementing, and evaluating the effectiveness of the program.

Section 5: Supplementation. This section focuses on the development of a supplementation program and provides instructions for planning, implementing, monitoring and evaluating the effectiveness of the program.

Section 6: Monitoring and Evaluation. This section focuses on the development of a monitoring and evaluation program to determine the effectiveness of the proposed action. This section will address both site-specific monitoring as well as monitoring overall program effectiveness.

Section 2.0

Restoration of Fluvial Fish Habitats on the Coeur d'Alene Indian Reservation

2.1 Introduction

The Bonneville Power Administration (BPA) contracted the Coeur d' Alene Indian Tribe, in 1990, to conduct the first of a series of baseline surveys on tributaries within the Reservation. The baseline surveys compiled information on 1) current habitat conditions for westslope cutthroat trout (*Oncorhynchus clarki lewisi*), 2) access to spawning tributaries for the same species, and 3) evaluation of existing stock conditions. These data serve as a basis for evaluating watershed processes and conditions and populations responses at the landscape level. Between 1991-1996 watershed conditions were documented and restoration strategies were developed for each targeted watershed. Subsequently, generalized restoration objectives were adopted into the Northwest Power Planning Council's 1995 Fish and Wildlife Program.

This section of the Project Management Plan documents the development of a uniform approach to restoration of fluvial fish habitats on the Coeur d'Alene Reservation, beginning with the definition of a desired future condition. Landscape level changes to the target watersheds are described and population responses to these changes are documented to set the stage for an analysis of limiting factors. Recommendations for restoring productivity to damaged stream and riparian systems are outlined. Finally, key steps to the identification and prioritization of rehabilitation efforts are described and a list of techniques and technical references are given.

2.2 Conceptual Approach to Stream Restoration

A conceptual approach to the restoration of fish habitat has been adapted from various sources as a guide for management efforts on the Coeur d'Alene Reservation. The conceptual model (Figure 2.1) is based on the ecological processes that shape riparian/stream ecosystems and focuses on 1) removing or modifying those land use impacts that are causing habitat degradation, 2) re-establishing riparian/stream linkages, and 3) restoring natural ecosystem processes.

In the Coeur d'Alene Basin dramatic effects on riparian/stream ecosystems have resulted from trapping, livestock grazing, dam construction, logging, mining, introduction of exotic species, channelization, urbanization, road construction, irrigation withdrawals, etc. In many instances, habitat degradation and consequent reduction in native trout populations has resulted from the cumulative effects of small changes to the aquatic ecosystem. Over time, these cumulative effects may be the most harmful to native fisheries because of their potential to alter ecosystem processes (Platts, 1991; Swanston, 1991). Thus, anthropogenic disturbance can significantly alter the productivity of ecosystems by adversely affecting species composition and diversity (Bjornn et al., 1977; Brusven and Prather, 1974; Hausle and Coble, 1976). Accordingly, the focus of interest is restoration of an ecosystem characterized by declines in biological diversity and ecosystem productivity.

Following a decision to restore a degraded stream reach, the desired future condition must be defined. The desired future condition describes the composition and ecological processes, ecosystem function, and structure, and is the ultimate goal of a restoration effort. Because many of the aquatic features on the Coeur d' Alene Reservation have been irreparably altered, it is not realistic to assume we can return to a system identical to that of pre-Columbian times, circa late 1800's.

The desired future condition, referred to in Figure 2.1, is defined as being functionally equivalent to the potential natural community. In other words, the goal is to restore those essential ecological conditions and processes necessary to maintain diverse and productive resident trout populations. This concept recognizes that a number of human-caused factors will preclude a complete return to the historical condition. However, under this scenario ecological processes (succession, natural disturbances, competition, evolution, etc.) and hydrological processes (sediment transport and deposition, flood plain storage and subsurface recharge, nutrient cycling, etc.) function in such a manner as to ensure a sustainable, intact ecosystem. Such a system has the potential to support a healthy resident trout fishery.

The first step in designing restoration efforts that will meet management objectives is to identify factors that limit the biological productivity and diversity of aquatic systems. Limiting factor analysis is commonly used to prioritize areas for treatment and guide management prescriptions. Furthermore, limiting factor analysis can be used to develop recommendations for correcting these limitations. These recommendations usually are addressed along a two phased approach. The first phase is to change existing land use practices using passive restoration techniques, while the second phase involves active restoration techniques.

A number of examples exist where a change in land use practices has resulted in dramatic improvements in habitat quality. This is defined as passive restoration (Figure 2.1). Often this is the least expensive solution and may be the only activity necessary to achieve habitat restoration goals. Examples of passive restoration include cessation of livestock grazing or excessive irrigation withdrawals, establishment of no-harvest buffers of an ecologically sufficient size, elimination of farming within riparian zones, and the cessation of chemical pollution of a riverine system.

In many degraded stream reaches the removal of the primary disturbances (passive restoration techniques) may achieve some success, but the continued presence of other limiting factors may prevent a complete recovery. This scenario is represented by the new ecosystem equilibrium in Figure 2.1. It is at this point that an active restoration program needs to be implemented. Active restoration is defined as those activities that encompass mechanical, chemical, or biological manipulations of the ecosystem in order to achieve the desired future condition. This includes, but is not limited to, the reintroduction of native species, structural habitat additions, the use of prescribed fire, and chemical manipulations. For active restoration efforts to be successful, they: 1) must be self sustaining; 2) they must facilitate the function of natural ecosystem processes; and 3) they must reestablish the linkages between the aquatic, riparian, and upland environments. The National Research Council (1992) has documented successful use of active restoration techniques for stream ecosystems.

In some instances, an active restoration program may proceed simultaneously with passive recovery prescriptions (e.g. riparian planting and bank stabilization, using bio-technical methods, in conjunction with cessation of livestock grazing). It should be recognized, however, that the most common cause of stream restoration failure is the implementation of active restoration activities before adverse land use practices have been stopped.

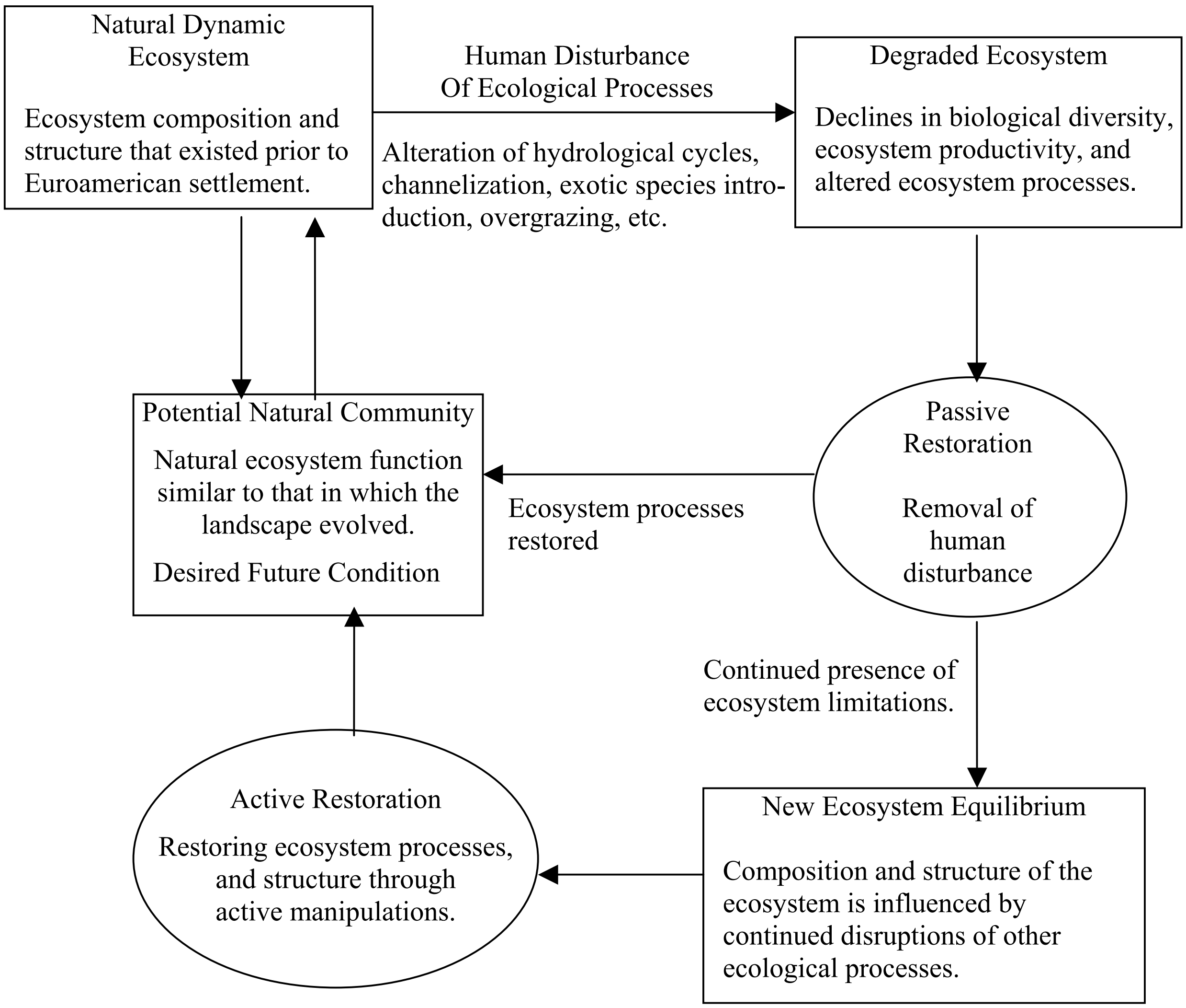


Figure 2.1. Conceptual Pathways of Ecological Restoration (Kauffman et. al. 1993).

2.3 Application of the Conceptual Approach

2.3.1. General Description of the Project Area

Coeur d'Alene Lake

Coeur d'Alene Lake is the second largest lake in Idaho and is located in the panhandle section of northern Idaho. Population centers are located in the Northern most shoreline of Coeur d'Alene Lake (Coeur d'Alene) and at the mouth of the Coeur d'Alene River (Harrison). The lake is located in two Idaho counties: Kootenai and Benewah. The city of Coeur d'Alene is the largest in Kootenai County and Harrison is the second largest in Benewah County. The largest town in Benewah County (St. Maries) lies about 12 miles upstream of Coeur d'Alene Lake on the St. Joe River.

Coeur d'Alene Lake is within the 17,300 square kilometer Spokane River drainage basin. The lake lies in a naturally dammed river valley with the outflow currently controlled by Post Falls Dam. Post Falls Dam controls the level of the St. Joe River at the town of St. Maries, like the lake. At full pool (lake elevation 648.7 meters) the lake covers 129 square kilometers and at minimum pool level (lake elevation of 646.2 meters) the lake covers 122 square kilometers. The lake is 26 miles long and anywhere from 1 to 6 miles wide. The lakes mean depth is 22 meters with a maximum depth of 63.7 meters. Morphometric data was taken from Woods and Barenbrock (1994).

The two principle tributaries to Coeur d'Alene Lake, the Coeur d'Alene and St. Joe Rivers, drain the Coeur d'Alene and St. Joe Mountains which lie to the east. These mountains are composed primarily of metasedimentary rocks of the belt group with local intrusions of granitics. Lower elevations are composed primarily of glaciofluvial deposits. The southern end of Coeur d'Alene Lake is made up of four shallow lakes (Hidden, Round, Chatcolet, and Benewah) flooded as a result of construction of Post Falls Dam.

The regional climate is subhumid-temperate with cool, wet winters and warm, dry summers. The lake receives about 25.4 inches of precipitation annually with more in the higher elevations around the lake (38.3 inches at Wallace, ID). A distinct precipitation season typically begins in October or November and continues through April or May. Approximately two-thirds of annual precipitation occurs during this period. The average daily maximum temperature in July is 86° F, the average daily minimum in January is 22° F. Moist, Pacific air masses that enter the area in late winter and early spring often generate rain-on-snow events. Geological data was taken from U.S. Department of Agriculture (1984).

Target Tributaries

Four target tributaries, including Alder, Evans, Benewah, and Lake Creeks have been identified and described in previous reports (Lillengreen 1993; Lillengreen, et. al. 1996; Kootenai-Shoshone Soil Conservation District 1991; CDA Tribe 1998). Basin morphometrics for these watersheds were derived from the Tribal GIS database following the definitions of Gardiner (1990), and are given in Table 2.1.

These watersheds have evolved and adapted to a series of geologic and climatic events, including general regional uplift, volcanism, intrusion of granite materials, and several stages of glaciation and climate change. The historic range of conditions resulted in watersheds and biotic communities that have developed and evolved with an operating range and resiliency that allows them to adjust to both frequent and rare events. Recently, opening lands on the Reservation for the 1910 Homestead Lottery dramatically increased the human population that exerted stresses on the aquatic and terrestrial ecosystems. Anthropogenic changes, such as, urbanization, construction of Post Falls Dam, conversion of forests and wetlands to pasture and agricultural uses, road construction, and introduction of exotic species have disturbed many natural processes of Reservation watersheds and their biotic systems.

Table 2.1 Basin morphometry of the Lake Creek, Benewah Creek, Alder Creek and Evans Creek watersheds.

Characteristic	Lake Creek	Benewah Creek	Alder Creek	Evans Creek
Basin Area	36.1 mi^2 (23,117 ac.)	58.5 mi^2 (37,447 ac.)	26.6 mi^2 (17,047 ac.)	13.3 mi^2 (8,512 ac)
Basin Length	10.1 mi.	13.8 mi.	12.6 mi.	6.5 mi.
Basin Relief	3,077 ft.	2,534 ft.	2,690 ft.	3,278
Basin Perimeter	34.3 mi.	51.2 mi.	26.9 mi.	17.3 mi.
Relief Ratio	0.057	0.034	0.040	0.095
Channel Length*	95.0 mi.	136.5 mi.	68.4 mi.	29.0 mi.
Drainage Density	2.51 mi/mi^2	2.33 mi/mi^2	2.54 mi/mi^2	2.18 mi/mi^2

*Includes intermittent tributaries

The climate and hydrology of the affected watersheds are similar in that they are influenced by the maritime air masses from the pacific coast, which are modified by continental air masses from Canada. Summers are mild and relatively dry, while fall, winter, and spring brings abundant moisture in the form of both rain and snow. Winter storms originating from the Pacific Ocean that are relatively warm and loaded with moisture are not uncommon to the Reservation. Warm, moist air masses are the ingredients for rapid melt and runoff where the snow pack is deep enough to hold significant amounts of water and temperatures are not very cold. The combination of these weather and snow pack conditions is common in the target watersheds, where the majority of basin area ranges from 3,000 to 4,500 feet. The rain that often accompanies these storms is added directly to the runoff, since the soils are either saturated of frozen in the early spring.

Morphology, aspect, and vegetative cover can influence the magnitude and frequency of these events. Large openings that permit free air movement over the snow pack can accelerate the rate of snow pack depletion. Openings from fires, insects and disease, and wind have always existed in the watersheds and have enhanced this rain-on-snow phenomenon. More recently, however, clearing of land for homesteads, logging, pasture, and agriculture have substantially enhanced this phenomenon. In Lake Creek for example, where nearly 40 percent of the basin area has been cleared for agriculture, peak discharges have increased by an estimated 55% for 100-year events when compared with the pre-settlement period (CDA Tribe, 1998). Lesser amounts of forest clearing have occurred in the other affected watersheds, suggesting measurable increases in peak discharges for these areas as well.

One of the more profound disturbances that the watersheds have been subjected to is from road construction. On slopes, roads intercept the downward movement of subsurface water and cause it to flow rapidly on the surface. Road location and construction has created erosion rates far beyond those under which the watersheds and streams evolved. Furthermore, this road system has been constructed in many of the most sensitive locations (floodplains, and unstable land types) within the watersheds. The density of unimproved roads exceeds 2.5-miles/mile^2 in each of the affected watersheds.

All the hydrologic responses that occur within a watershed are integrated in the stream channel. Unfortunately, disturbances to stream channels and riparian areas have been common occurrences in all the watersheds. Early development in the 20th century, primarily construction of railroads and logging, disrupted the function and process of the riparian areas and stream channels within them. Railroad and logging enterprises striped the most accessible timber from the valley and stream bottoms in Lake, Benewah and Alder Creeks. Additionally, a conveyance system using flumes and splash dams was constructed in the Benewah Valley in 1915-1916 to speed the delivery of local logs to markets located outside the Reservation. The legacy of these actions continues today since the ability of streams and riparian systems was disrupted beyond any semblance of equilibrium.

2.3.2 Physical, Chemical and Biological Assessment of Conditions

Conditions that provide the impetus for stream corridor restoration activities include degraded stream channel conditions and degraded habitat. A thorough analysis of the cause or causes of these alterations or impairments is fundamental to identifying management opportunities and constraints and to defining realistic and attainable restoration objectives. There are no hard-and-fast rules about which attributes are most useful in characterizing the condition of stream corridor structure and functions. However, since the ultimate goal is to establish restoration objectives in terms of the structure and functions of the stream corridor, it is useful to characterize those attributes that either measure or index the eventual attainment of the desired ecological condition.

Assessments of watershed function were conducted from 1991-1998 in Lake, Benewah, Evans and Alder Creeks to examine landscape level functions, riparian and instream habitat conditions, water quality conditions, distribution and condition of spawning gravels, and population dynamics of trout species. Results of these assessments are summarized in this section and serve as documentation of existing conditions and their relation to historic potential, as well as, the desired future ecological condition.

Landscape Level Function

Published information on cutthroat trout status and distribution, life-history characteristics, and habitat relationships was used to generate the parameters for a landscape level, habitat condition matrix. Parameters used to determine baseline condition in the affected watersheds include: watershed elevation, percent watershed area affected by rain-on-snow events, percent sensitive land type, exotic species presence or absence, road density, percent riparian harvest, percent forest openings, potential for adfluvial passage (connectivity), and water temperature. Each parameter was given a qualitative rating, ranging from good to poor, to assess the affects of ecosystem processes and human alterations on the viability of cutthroat trout populations (Tables 2.2 – 2.5).

A) Elevation – Elevation was suggested by Lee et al (1997) as an important variable in determining the population status of salmonids throughout its range. Because elevation is related to mean annual temperature it is likely that streams at higher elevation will remain colder through summer months than lower elevation streams. For the matrix, less than 40% of the basin area below 4500 ft. is ranked as good, 41%-69% is ranked as moderate, and greater than 70% is poor.

B) Rain-on-Snow – Because streams in the transitional snow zone are more prone to flashy flood flows during periods while cutthroat trout are spawning and during initial egg incubation, these streams may have lower egg to fry survival than eggs in streams within either the snow or rain zones (Swanston 1991). For the matrix, less than 33% of the basin area between 3000 and 4500 ft. is ranked as good, 33%-67% is moderate, and greater than 67% is poor.

C) % Sensitive Land Type – Sensitive land types are soils that have a high probability of erosion. Sediment within streams can reduce egg-to-fry survival as well as limit access to substrate interstices that are important cover during rearing and overwintering (Chapman 1988, Stowell et al. 1983, Platts et al. 1989). Therefore, land management activities within these land types can increase erosion and have a negative effect on westslope cutthroat trout. For the matrix, less than 15% of the area in sensitive land types will be considered a good condition, between 15%-30% is moderate, and greater than 30% is poor.

D) Exotic Species – Numerous species have been introduced throughout the Pacific Northwest. While many of these species have negative affects on cutthroat trout and other native fishes, brook trout are of primary concern within Reservation watersheds. Several studies have clearly demonstrated that declining cutthroat trout numbers are related to the introduction of brook trout (Griffith 1972, 1974, 1988; Marnell 1986, 1987, 1988; Moyle and Vondracek 1985). For the matrix, absence of brook trout within the affected watershed is indicative of good condition, the presence of low numbers indicates a moderate condition rating, and the presence of high numbers indicates a poor condition.

E) Road Density – Lee et al. (1997) found that road density had the highest correlation of any anthropogenic action on the population status of cutthroat trout. Increasing road density has a negative affect on the environmental baseline condition. For the matrix, less than 0.7 miles/miles^2 is a good condition, between 0.7 and 1.7 miles/miles^2 is moderate, and greater than 1.7 miles/miles^2 is poor.

F) Riparian Harvest – Streamside riparian canopy closure affects both nutrient and energy inputs to streams. Older age riparian stands have a moderating affect on stream temperature, provide large organic debris, and affect nutrient input and cycling (Brown and Krygier 1970, Bisson et al. 1987, Murphy and Meehan 1991). For the matrix, riparian areas with less than 13% harvested in the last 15 years are assigned a good condition, between 13%-33% harvested is moderate, and greater than 33% is poor.

G) % Forest Openings – Peak flows during floods are often exacerbated by the percent of the basin harvested (Chamberlin et al 1991). These increased peak flows can reduce survival of eggs and embryos while they are in the gravel (Hicks et al. 1991). For this matrix we have adopted Forest Service values to represent baseline conditions. Values less than 15% represent good conditions, 15%-30% represent moderate conditions, and greater than 30% is poor.

H) Connectivity – A watershed will be determined to be in good condition if adfluvial fish passage is assured in high order streams year round, in moderate condition if adfluvial passage can be completed during all but low water conditions, and poor if adfluvial passage can not be completed at any time of the year.

I) Stream Temperature – An average 7-day running maximum water temperature of less than 16°C indicates good condition, between 16-22° is moderate, and greater than 22° is poor. Stream temperatures are measured in the highest order stream within the watershed.

Table 2.2 Baseline Condition Matrix for Lake Creek.

Condition Indicator	Population/Environmental Condition		
	GOOD	MOD	POOR
Elevation (% below 4500)			97.7
Rain on Snow (% between 3000-4500)	29.6		
% Sensitive Landtype			X
Exotic Species	X		
Road Density (m/m^2)			3.4
Riparian Harvest		X	
% Forest Openings			X
Connectivity	X		
Stream Temperature		X	
Integrated Condition		X	

Table 2.3 Baseline Condition Matrix for Benewah Creek.

Condition Indicator	Population/Environmental Condition		
	GOOD	MOD	POOR
Elevation (% below 4500)			99.6
Rain on Snow (% between 3000-4500)		58.0	
% Sensitive Landtype			X
Exotic Species		X	
Road Density (m/m^2)			5.4
Riparian Harvest			X
% Forest Openings		X	
Connectivity	X		
Stream Temperature		X	
Integrated Condition		X	

Table 2.4 Baseline Condition Matrix for Alder Creek.

Condition Indicator	Population/Environmental Condition		
	GOOD	MOD	POOR
Elevation (% below 4500)			99.4
Rain on Snow (% between 3000-4500)			75.0
% Sensitive Landtype			X
Exotic Species			X
Road Density (m/m^2)			5.7
Riparian Harvest		X	
% Forest Openings		X	
Connectivity			X
Stream Temperature		X	
Integrated Condition			X

Table 2.5 Baseline Condition Matrix for Evans Creek.

Condition Indicator	Population/Environmental Condition		
	GOOD	MOD	POOR
Elevation (% below 4500)			86.9
Rain on Snow (% between 3000-4500)		60.2	
% Sensitive Landtype			X
Exotic Species	X		
Road Density (m/m^2)			5.3
Riparian Harvest	X		
% Forest Openings	X		
Connectivity	X		
Stream Temperature	X		
Integrated Condition	X		

Riparian Habitat Condition

The functional value of riparian areas is highly variable within the target drainages, however, some consideration of riparian habitats is essential in addressing limiting factors associated with high summer water temperatures and habitat diversity. Forest crown closure is used in this management plan as an index of riparian function because it assesses the ability of riparian areas to: 1) shade stream channels from direct sunlight, 2) provide sustainable sources of large woody debris, and 3) input allochthonous detritus, which is the basis for invertebrate production in small streams (Vannote et al. 1980).

Most stream temperature concerns in forest ecosystems have focused on summertime increases associated with forest harvesting (Beschta et al. 1987). The principle source of energy for heating small streams during summer conditions is incoming solar energy striking the water surface. The more canopy removed, the greater is the exposure of the stream to this heat source. Most of this incoming energy is stored in the stream, and its temperature rises accordingly. Furthermore, once stream temperature is increased, the heat is not readily dissipated to the atmosphere as it flows through a shaded reach. Thus, additional energy inputs to small streams can have an additive effect on downstream temperatures. This fact emphasizes both the importance of maintaining intact buffer strips and the need for reforestation beginning in the upper reaches of watersheds.

Maps showing forest crown closure in riparian areas have been produced for each target drainage using a database maintained by the Tribal GIS Program (Figures 2.2 - 2.5). As a rule of thumb, riparian areas with less than 10 percent forest crown closure have very little functional value and are high priority areas for restoration treatments. Riparian areas with crown closure between 10 and 40 percent have low functional value and should be given second priority in assigning treatment prescriptions. Riparian areas with between 40 and 70 percent crown closure generally have moderate to high functional values. These areas may serve as models for designing riparian treatments in more degraded areas, but still may require treatment to attain their full functional potential.

Table 2.6 lists targets for stream canopy closure by elevation zone to maintain mean weekly-maximum water temperatures of 15° C or less. Where appropriate, these target values can provide the basis for formulating project specific objectives related to canopy closure.

Table 2.6. Target stream canopy closure for northern Idaho (north of the Salmon River).

Elevation Zones (feet)	Target Canopy Cover	
	Bull trout (13° C)	Cutthroat trout (15° C)
>5,200	29	6
5,000-5,199	35	12
4,800-4,999	41	18
4,600-4,799	48	24
4,400-4,599	54	30
4,200-4,399	60	36
4,000-4,199	66	43
3,800-3,999	72	49
3,600-3,799	79	55
3,400-3,599	85	61
3,200-3,399	91	67
3,000-3,199	97	73
2,800-2,999	100	80
2,600-2,799	100	86
2,400-2,599	100	92
2,200-2,399	100	100

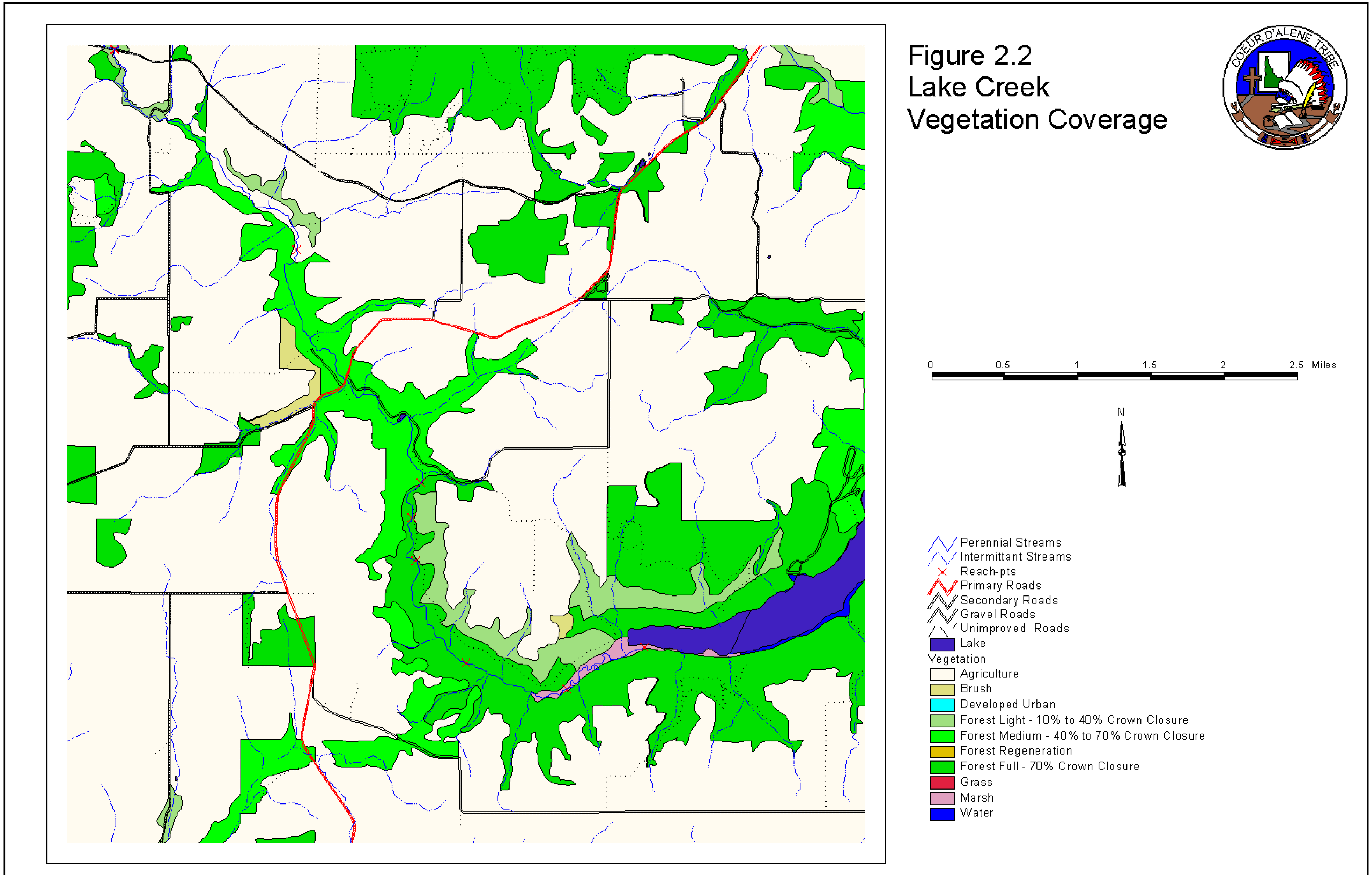
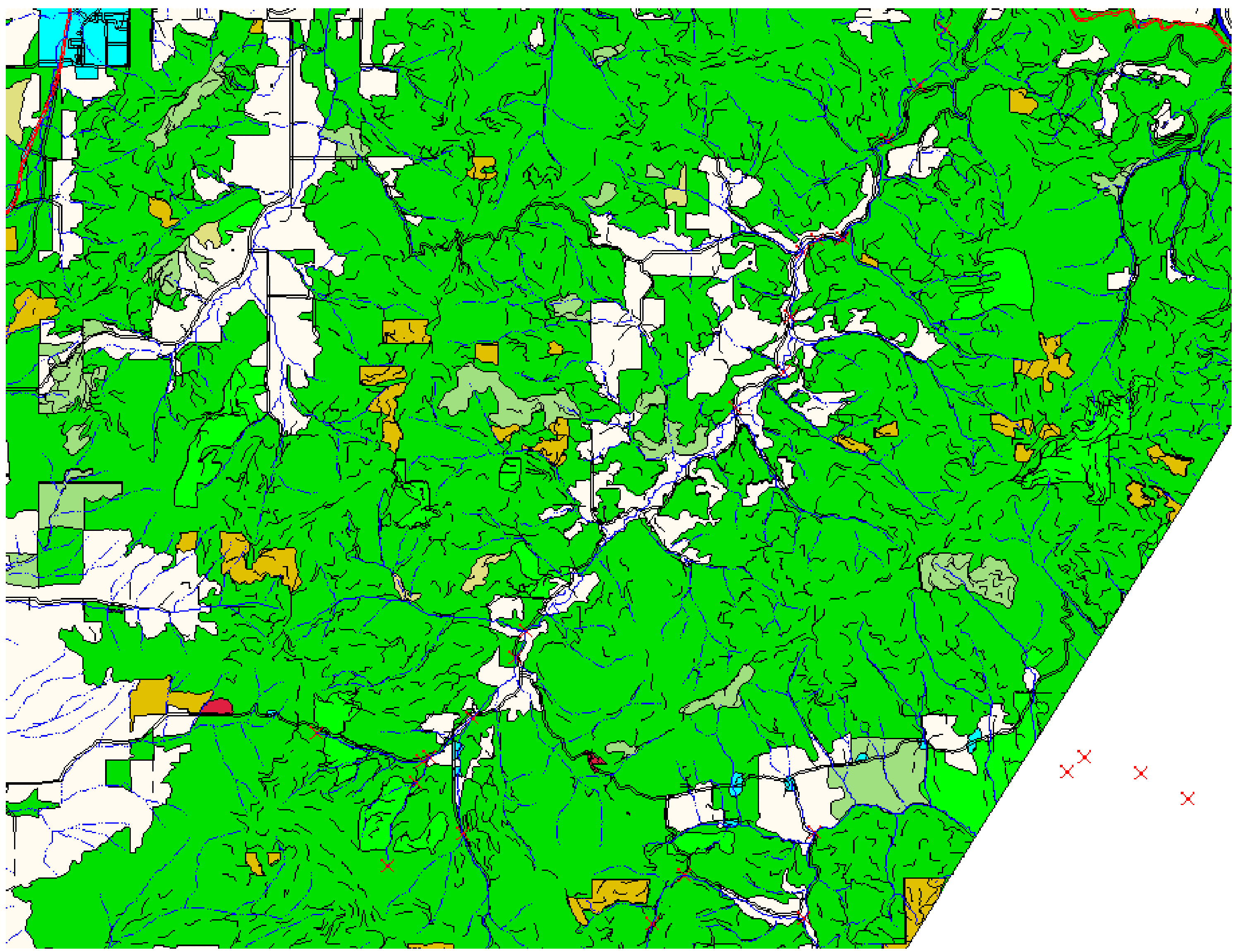


Figure 2.2
Lake Creek
Vegetation Coverage
COEUR D'ALENE TRIBE
0
0.5
1
1.5
2
2.5 Miles
N
Perennial Streams
Intermittant Streams
Reach-pts
Primary Roads
Secondary Roads
Gravel Roads
Unimproved Roads
Lake
Vegetation
Agriculture
Brush
Developed Urban
Forest Light - 10% to 40% Crown Closure
Forest Medium - 40% to 70% Crown Closure
Forest Regeneration
Forest Full - 70% Crown Closure
Grass
Marsh
Water

Figure 2.3 Benewah Creek Vegetation Coverage



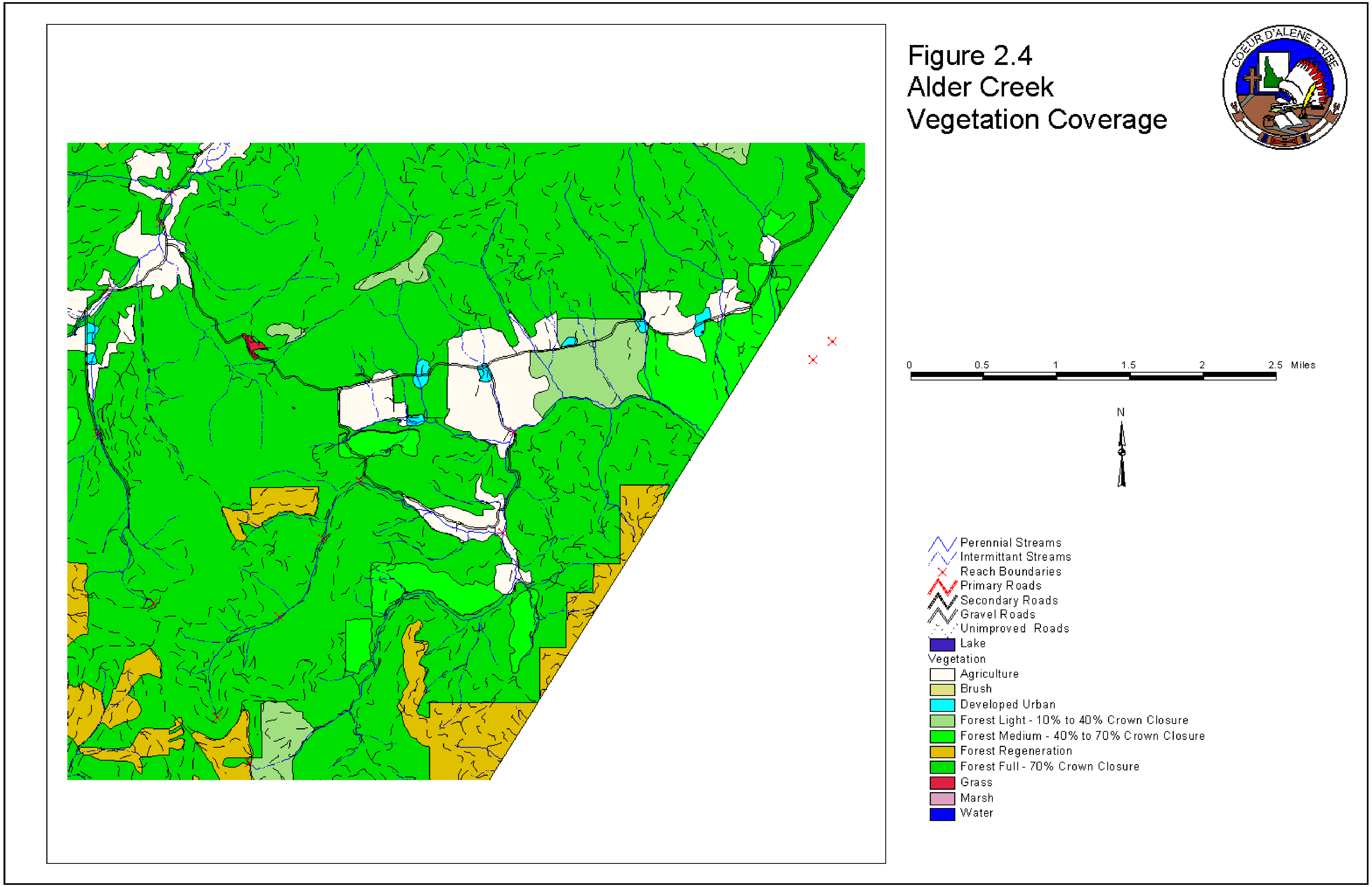


Figure 2.4
Alder Creek
Vegetation Coverage
0
0.5
1
1.5
2
2.5 Miles
N
Perennial Streams
Intermittant Streams
Reach Boundaries
Primary Roads
Secondary Roads
Gravel Roads
Unimproved Roads
Lake
Vegetation
Agriculture
Brush
Developed Urban
Forest Light - 10% to 40% Crown Closure
Forest Medium - 40% to 70% Crown Closure
Forest Regeneration
Forest Full - 70% Crown Closure
Grass
Marsh
Water

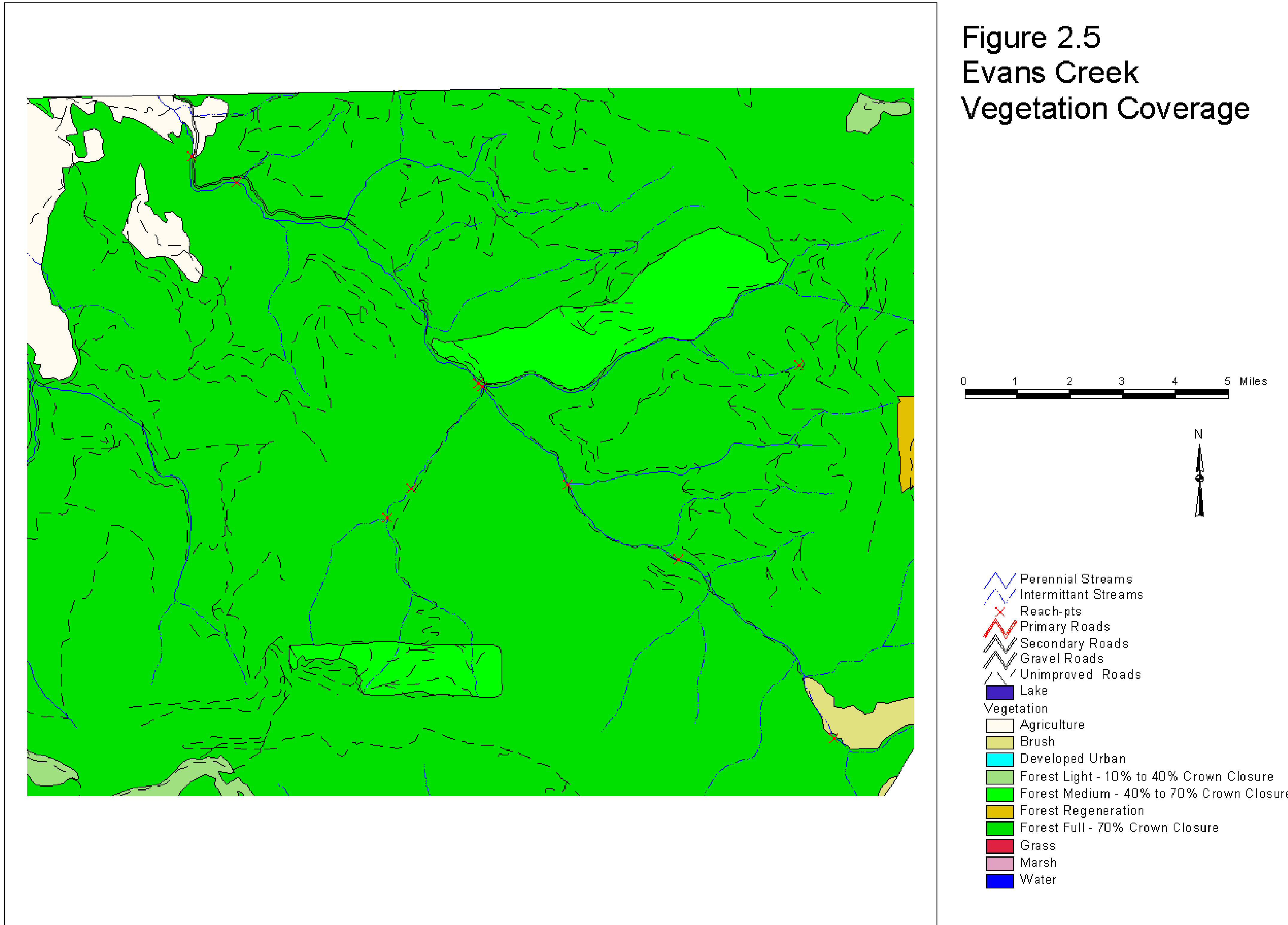


Figure 2.5
Evans Creek
Vegetation Coverage

Instream Habitat Condition

The Fish, Water and Wildlife Program conducted channel and habitat surveys of the target tributaries in 1993 and 1994. Channel surveys described basic morphological features including bankfull width, bankfull depth, width/depth ratio, entrenchment, sinuosity, gradient, dominant substrate, channel stability, and stream stability according to the methods of Rosgen (1985), Pfancuch (1975) and Kappesser (1992). Habitat surveys followed the procedures in the Timber, Fish, and Wildlife Ambient Stream Monitoring Handbook (Ralph 1990) and classified both habitat types and riparian condition. See appendix A for complete results of these surveys.

Stream gradients in the target drainages range from 1-10%, with the dominant condition ranging from 1-3%. This places the majority of the target systems in the response category of Montgomery and Buffington (1993). The response condition implies that changes in sediment loads will cause physical changes in channel characteristics including width, depth, sinuosity, and channel bed characteristics. These can be positive or negative for salmonid habitat depending on whether sediment loads are decreased or increased, respectively. More precisely, the response characteristic implies that sediment inputs into most reaches of Lake, Benewah and Alder creeks are likely to be deposited within the channel, and will not be transported under the majority of streamflow conditions. Based on sediment budget results, the present response condition for Lake Creek is fine sediment aggradation (CDA Tribe 1998), and the same is likely true for Benewah and Alder creeks as well. Conversely, a significant portion of the Evans Creek watershed falls into the transport category of Montgomery and Buffington (1993), indicating that sediment inputs are transported under the majority of streamflow conditions.

The channel stability index of Pfancuch (1975) assigns relative scores to factors of channel stability including mass wasting potential, debris jam potential, bank vegetation density, channel capacity, in-channel erosion and deposition, and characteristics of bottom substrates. The relative scores are summed to get a numeric channel stability rating. Most Lake Creek ratings were in the fair category, with poor ratings assigned to portions of upper Lake Creek and West Fork Lake Creek. Benewah Creek ratings were good in the lowermost reaches, but degraded to fair or poor ratings in the middle reaches of the drainage. Stability ratings generally did not reach good or excellent categories due to lack of bank vegetation and bank cutting observed in the surveyed reaches. Ratings for Alder and Evans creeks were generally fair or good, with only isolated occurrences of poor condition.

Stream stability was measured with the Riffle Armor Stability Index (Kappesser 1992). A total of 37 RASI scores were generated for seven reaches in Lake Creek, 40 scores for eight reaches in Benewah Creek, 39 scores for eight reaches in Alder Creek, and 28 scores for five reaches in Evans Creek. A majority of scores (88 of 144) were <70, indicating geomorphic stability. Forty-five of 144 scores fall in the range 70-90, which Kappesser ascribes to systems entering, or about to enter, a period of instability. Eleven of 144 scores were >90, indicating instability. The highest scores were from reaches within or immediately downstream of lands dominated by agricultural and grazing land uses, where the greatest sediment input is likely to occur.

Measurements for additional habitat parameters generally considered as important indicators of quality trout habitat are summarized in Table 2.7.

Chemical Condition

A modified habitat suitability index (HSI) model was used to evaluate the effect of water quality parameters on cutthroat trout populations within and among the target watersheds. An HSI score was calculated for the water quality subcomponent of the model described by Hickman and Raleigh (1982). Model variables included: average maximum water temperature (V_1); average minimum dissolved oxygen (V_3); annual maximal or minimal pH (V_{13}); and average annual base flow as a percentage of the average annual daily flow (V_{14}). Water quality data collected in 1997 and in 1998 were used as input variables. The following modifications were made to address site specific conditions: a seven-day running average of maximum temperature was used; and average minimum dissolved oxygen was calculated for the period of greatest average water temperatures. Continuous discharge measurements were only available for the two sample sites on Lake Creek. For the remaining sites, average annual daily flow was calculated based on a minimum of 12 discharge measurements taken during the year, and average annual base flow was calculated for the period of low flow which corresponded to the greatest average water temperatures.

Table 2.7 Current (1994) measures of key habitat parameters compared to optimal conditions for westslope cutthroat trout, as described by Hickman and Raleigh (1982).

Habitat Condition	*Lake Creek*	*Benewah Creek*	*Evans Creek*	*Alder Creek*	**Optimal Condition**
Average Residual Pool Depth	1.9 ft.	2.0 ft.	2.5 ft.	2.0 ft.	5.0 ft.
Average Canopy Cover	13.9%	36.6%	40.1%	23.8%	75%
# Large Woody Debris/Lineal Distance	<0.1/m	<0.1/m	<0.1/m	<0.1/m	--
Riffle:Pool Ratio	3.6:1	1.8:1	10.6:1	1.2:1	3:2
Average Percent Fine Sediment	19.1%	10.9%	16.8%	37.6%	<10%

The final HSI score was calculated using both a compensatory and a non-compensatory method. The compensatory method assumes that moderately degraded water quality conditions can be partially compensated for by good physical habitat conditions. The non-compensatory method assumes that degraded water quality conditions cannot be compensated for, and variables with suitability indices (SI) < 0.4 become limiting factors on habitat suitability. For purposes of interpretation, HSI with values ranging from 0 - 0.25 were considered very poor; 0.25 – 0.4 were poor; 0.4 – 0.6 were good; and 0.6 – 1.0 were very good.

The suitability index (SI) values for individual water quality parameters vary considerably between sample locations (Table 2.8). The greatest variability occurs for the temperature parameter (V_1), where the SI ranges from 0 to 1.0. Water temperatures are limiting for the mainstem of Benewah Creek, lower Lake Creek, and lower Windfall Creek. The SI for the base flow parameter (SI_{14}) is < 0.4 for all sample locations except for Evans Creek and mainstem Benewah Creek, indicating that base flow is also a limiting factor at most locations. The SI for dissolved oxygen (SI_3) and pH (SI_{13}) are generally greater than 0.8, and therefore are not considered limiting. The exception occurs in School House Creek, located in the Benewah Creek watershed, where dissolved oxygen is limiting (SI_3=0.3) during the period of warmest water temperatures.

HSI scores that are calculated using the non-compensatory method show a very poor to poor rating for all sample locations, with the exception of Evans Creek, which is considered good. In other words, when habitat suitability is rated based on water quality parameters alone, then all sample locations, with the exception of Evans Creek, are rated very poor to poor with regard to cutthroat trout preferences. In six of ten locations, however, differences between HSI calculations using the compensatory versus non-compensatory method indicate that good habitat conditions have the potential to partially compensate for short-term degradation in water quality. These sites include upper Lake Creek, S.F. Benewah Creek, School House Creek, W.F. Benewah Creek, Evans Creek, and Alder Creek. Lower Lake Creek, the mainstem of Benewah Creek, and lower Windfall Creek are considered very poor with respect to water quality, regardless of the analysis method used.

Table 2.8 Habitat Suitability Index (HSI) calculations for riverine cutthroat trout.

Location	V_1	SI_1	V_3	SI_3	V_{13}	SI_{13}	V_{14}	SI_{14}	Comp HSI	Non-Comp HSI
L. Lake	22.6	0	9.5	1	6.8/7.7	1	9	0.2	0	0
U. Lake	17.9	0.78	7.9	0.9	6.5/7.5	1	13	0.25	0.65	0.25
L. Benewah	23	0	8.9	1	7.0/8.3	1	18	0.4	0	0
U. Benewah	22.8	0	7.7	0.87	6.7/7.6	1	18	0.4	0	0
S.E. Benewah	14.7	1	9.7	1	6.6/7.6	1	16	0.32	0.75	0.32
School House	16.4	0.92	5.7	0.3	6.8/7.4	1	6	0.15	0.45	0.15
W.F. Benewah	16.6	0.9	9.3	1	6.7/7.5	1	11	0.25	0.69	0.25
Windfall	25.1	0	7.8	0.89	6.7/7.6	1	13	0.25	0	0
Evans	16.4	0.92	9.6	1	6.3/7.7	0.95	28	0.6	0.85	0.6
Alder	20.6	0.45	9.6	1	6.8/7.8	1	16	0.32	0.62	0.32

Distribution and Condition of Spawning Gravels

Potential spawning tributaries were identified over the past six years based on trapping results and population surveys. Active migration into tributaries by adult fish and/or presence of young-of-the-year trout was used as an indication of spawning activity for the purposes of this survey. Habitat features and the area of potential spawning gravel were measured at established sample sites in each tributary. Refer to Peters et al. (1999) for a detailed discussion on sample and analysis methodology.

Our findings indicate that cutthroat trout primarily reside and spawn in reaches of small (1-4 meters wide) tributaries with moderate gradients (1.0-4.4%) and suitable spawning gravels (Table 2.9). Substrate embeddedness was high at the sampled sites, averaging about 50 percent. Proportion of potential spawning gravel was low and did not vary much among sites (mean = 4.1±2.1). We found no association between abundance of suitable spawning gravels and reach gradient, proportion of riffle habitat, proportion of pea gravel, or proportion of gravel substrate.

Predicted emergence success was generally high, averaging 28.4 percent for all sampled sites (Table 2.10). Emergence success was positively correlated to the fredle index (F_i) at each site (r = 0.79). The lowest values were observed in upper Lake Creek, where silt and sand sized particles comprised 63 and 89 percent of the core samples, respectively at the two sampled sites. Despite the presence of suitable spawning gravels at these sites, this data suggests that these sites represent primary rearing areas rather than the most productive spawning habitat in the upper watershed. Fry production was positively correlated to the availability of spawning gravel in the sampled reaches (r = 0.78). The production potentials for sampled sites ranged from 0 to 31.2 fry/100 square meters (mean=13.7±8.2). The highest calculated values occurred in several tributaries to Benewah Creek.

Population Status

Viable populations of adfluvial westslope cutthroat trout currently exist in Lake Creek and Benewah Creek, while resident populations of westslope cutthroat are found in all the restoration target drainages. Recent biological evaluations of these populations by tribal experts, however, classify them as a species at risk based on both low population numbers and habitat losses (Lillengreen, et. al., 1996). Furthermore, the U.S. Fish and Wildlife Service is currently (spring 1999) reviewing the range wide status of westslope cutthroat trout in consideration for listing as threatened under the Endangered Species Act.

Range wide causes of decline include competition with and predation by non-native species, genetic introgression, overfishing, habitat loss and fragmentation, and habitat degradation (Likens 1984; Likens and Graham 1988; Rieman and Apperson 1989; McIntyre and Rieman 1995). In Idaho, habitat loss was identified as the primary cause of decline in streams supporting depressed populations (Rieman and

Table 2.9. Means of habitat features in spawning reaches of Alder (A), Benewah (B), Evans (E), and Lake (L) creeks and their major tributaries.

Reach	Gradient (%)	Width (ft.)	Depth (ft.)	Embeddedness [a]	Percent by Area					
					Spawning gravel	Riffle	Silt	Pea gravel	Gravel	Rubble
Alder										
A9	2.3	6.3	1.1	2.4	5.5	30	10	65	25	0
North Fork	2.3	11.6	1.5	2.6	2.8	9	10	51	33	6
Benewah										
B12	1.0	16.0	2.4	3.4	1.5	14	8	45	40	7
Bull	3.0	6.3	1.4	3.0	1.1	42	4	58	38	0
School House	1.6	5.9	1.5	4.0	5.7	14	7	64	28	1
South Fork	3.9	7.3	1.0	3.2	3.3	27	5	34	31	13
West Fork	4.4	5.0	0.9	2.6	6.9	20	9	61	27	2
Whitetail	4.2	6.3	1.0	2.2	8.9	31	7	34	49	10
Windfall	1.6	6.6	1.1	2.4	5.1	10	5	41	38	16
Evans										
R5	6.0	10.0	1.5	1.0	1.3	0	7	41	27	15
R6	7.5	3.5	0.9	1.5	2.4	0	10	46	33	8
R7	7.5	4.0	0.9	3.0	3.5	0	7	47	35	7
East Fork	4.0	4.5	1.5	1.0	3.9	0	6	46	48	0
South Fork	9.5	3.0	0.9	3.0	4.1	0	3	26	53	15
Lake										
L8	1.2	5.5	1.6	3.8	3.5	32	6	66	28	0
Bozard	2.4	5.7	1.4	3.3	4.9	40	5	36	48	11
West Fork	3.9	5.1	0.8	2.9	5.0	44	7	43	46	4

[a] Rated on a scale from1 to 4 for percent of substrate embedded: 1 = >75%; 2 = 50 – 75%; 3 = 25 – 50%; 4 = 0 – 25% (Platts et al. 1983).

Table 2.10. Number of cores, mean fredle index (F_i) of substrate composition of cores (range in parentheses), predicted mean emergence success, and mean estimated production potential for reaches in Alder (A), Benewah (B), Evans (E), and Lake (L) creek subbasins and their primary tributaries.

Reach or subbasin	Number of cores	F_i	Emergence success	Production potential (# of fry/ 100 square meters)
Alder	**5**	**7.8 (6.0-11.2)**	**31.9**	**11.8**
A9	1	6.0	30.6	19.8
North Fork	4	8.2 (7.0-11.2)	32.3	10.6
Benewah	**9**	**7.1 (2.4-16.6)**	**29.6**	**15.3**
B12	1	3.7	31.2	5.5
Bull	1	16.6	38.7	4.9
School House	1	5.3	28.4	19.0
South Fork	2	2.8 (2.4-3.1)	24.0	9.1
West Fork	2	5.9 (4.7-7.1)	26.9	24.0
Whitetail	1	7.6	29.6	31.2
Windfall	1	13.8	36.9	22.2
Evans	**8**	**8.8 (2.7-13.7)**	**31.5**	**11.1**
R5	1	7.1	30.6	4.9
R6	2	11.1 (8.5-13.7)	34.7	9.8
R7	2	10.4 (10.0-10.7)	34.7	14.5
East Fork	1	2.7	14.7	6.8
South Fork	2	8.8 (6.6-11.0)	33.8	16.0
Lake	**7**	**4.5 (0.8-7.1)**	**20.9**	**13.6**
L8	2	0.9 (0.8-0.9)	0.0	0.0
Bozard	2	5.4 (4.1-6.7)	28.2	16.6
West Fork	3	6.4 (5.9-7.1)	29.9	17.7
Totals	**29**	**7.1**	**28.4**	**13.0**

Apperson 1989). The following factors effectively limit the population of cutthroat trout in Reservation streams:

- Stochastic events that result in increased mortality of embryo, fry, and juvenile lifestages (e.g. peak flow events) have been exacerbated by land use practices during the last 60 years.
- Within each watershed poor habitat and water quality conditions have significantly reduced the geographical range of resident populations.
- Competition for limited space and food during base flow conditions cause displacement of juveniles into water quality limited stream reaches.
- Competitive interactions with introduced salmonids may result in replacement of native trout, particularly in Alder Creek and Benewah Creek.

Resident cutthroat trout populations in target tributaries were estimated in 1996, 1997, and 1998 using the removal-depletion method (Seber and LeCren 1967, Zippen 1958). Sample sites within each reach were selected to include habitat types representative of the reach as a whole. Sites were sampled in the summer to quantify the abundance and distribution of fishes during base flow conditions. An additional sampling effort in the fall attempted to capture young of the year fish that had been missed during the summer sampling period and to document fish migration in response to changing water quality conditions.

The general patterns of cutthroat trout abundance and distribution vary among the target watersheds and among years, but seem to be highly correlated to seasonal changes in water quality and quantity (figures 2.6 – 2.9). Cutthroat trout are sporadically distributed in the Lake Creek, Benewah Creek, and Alder Creek watersheds during both the summer and fall seasons. Distribution in the Evans Creek watershed is much more even, with a gradual decrease in density occurring as one moves to lower elevations in the watershed. Previous reports demonstrated that abundance of juvenile cutthroat is greatest in first and second order tributaries, suggesting a close link to the most heavily utilized spawning areas. Downstream displacement, however, has been recognized as a common occurrence when stream flows approach zero in the principle spawning tributaries. While not being unique, this mechanism has not been commonly reported for most salmonid populations in the Pacific Northwest. For most salmonid species, it has been demonstrated that instream movement is minimal; individuals may remain in limited areas for several weeks or months and may return to the same locations in successive years (Edmundson et al. 1968; Bachman 1984). Limiting migration in this way is thought to confer an adaptive advantage by maximizing the net energy intake of individuals (Puckett and Dill 1985).

Typical base flow conditions in the target watersheds force juvenile trout into small pools where competition for limited space and food may occur. Other authors have suggested that at high densities, competition for space among juveniles may lead to dispersal, downstream displacement or mortality in salmonids (Chapman 1962; Mason and Chapman 1965; Everest 1971; Erman and Leidy 1975; LeCren 1973). In water quality limited systems, such as Lake Creek, Benewah Creek, and Alder Creek, dispersal to downstream areas exposes juvenile cutthroat to suboptimal temperature conditions that increase stress, weaken individuals and may result in mortality.

Brook trout have been found in Alder Creek and Benewah Creek but not in Lake Creek and Evans Creek; the respective dates of introduction are unknown. These fish are distributed in fairly high numbers (up to $30/100m^2$) throughout the upper reaches of the Alder Creek watershed. Distribution in the Benewah Creek watershed is limited to the upper mainstem and a few of the primary tributaries and abundance is typically much lower than for cutthroat trout. In Alder Creek, however, brook trout are found in greater numbers than cutthroat trout in all but the lowermost stream reaches.

Cutthroat trout did not evolve with brook trout in the Benewah Creek and Alder Creek watersheds. Therefore, mechanisms that promote coexistence and resource partitioning have likely not developed. Griffith (1972) demonstrated that cutthroat trout fry emerge from the gravel later in the year than brook trout and, thus, age-0 cutthroat trout acquire a statistically significant length disadvantage that may continue throughout their lifetime. Such a size discrepancy may enhance resource partitioning, but in times of habitat shortage cutthroat trout may be at a disadvantage if they cannot hold territories against larger competitors. Competitive exclusion is a likely cause of decline for cutthroat trout in Alder Creek. Replacement of this kind, at least in stream environments, may be an irreversible process (Moyle and Vondracek 1985). This was found to be the case in Yellowstone National Park, where the introduction of brook trout has nearly always resulted in the disappearance of the cutthroat trout (Varley and Gresswell 1988). Implications for Benewah Creek are that cutthroat trout may have a difficult time recovering given continued water quality degradation and the persistence of brook trout.

Due to the persistence of adverse conditions in Reservation streams, cutthroat trout populations are thought to be at least moderately damaged (i.e. average spawning escapements fall between the minimum viable population and the number of adults needed to produce 50% of the carrying capacity of the stream environment). Reiman and Apperson (1989) estimated that populations considered as “strong” (greater than or equal to 50% of historic potential) by Idaho Department of Fish and Game (IDFG) remained in only 11% of the historic range within the State of Idaho. In contrast, none of the populations on the Coeur d'Alene Indian Reservation are considered “strong” (Table 2.11). The probability of persistence, as shown in table 2.11, was calculated based on methods described by Reiman and McIntyre (1993), but should be used only as an index of population resiliency. When used in this manner, probability of persistence will increase as population size increases or when the inter-annual variance in population size decreases.

Table 2.11. Mean annual population estimates, the estimated mean annual variance in the infinitesimal rate of population growth, and probabilities of persistence over 100 years for westslope cutthroat trout populations monitored on the Coeur d’Alene Reservation. The 95% confidence interval is shown in parentheses.

Stream	Years	Mean Annual Population Estimate	Variance	Probability Of Persistence
Alder Creek	3	808	0.03 (0.02-0.04)	0.58
Benewah Creek	3	5,553	0.16 (0.04-0.36)	0.67
Evans Creek	3	2,675	0.33 (0.05-0.71)	0.45
Lake Creek	3	4,946	0.14 (0.02-0.26)	0.70

Despite the apparent instability of cutthroat trout populations on the Reservation, preliminary genetic analyses of these same populations show that relatively pure stocks exist in reservation waters (Spruell et al. 1999). Only minimal amounts of hybridization with rainbow trout (Oncorhynchus mykiss) have occurred and some populations show no hybridization at all. Thus, it could be theorized that even though the populations are not “strong” they are not threatened to a large extent with hybridization. Implications here are that if the effect of limiting factors can be reduced, then genetically pure populations would have a chance to recover.

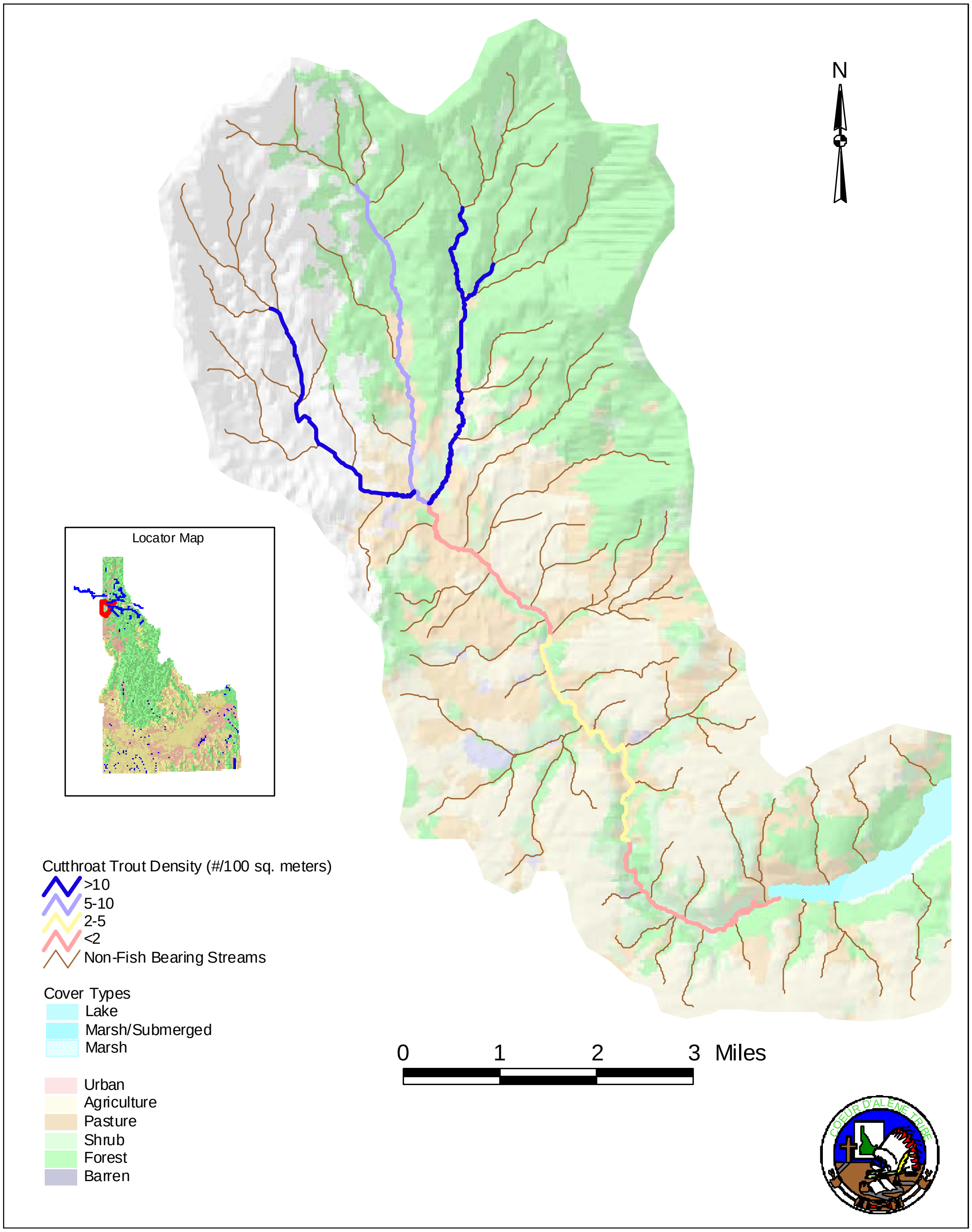


Figure 2.6 Distribution of westslope cutthroat trout in Lake Creek. Density is reported in number of fish/100 square meters of stream area, with density computed as the average during the three-year period 1996-1998.

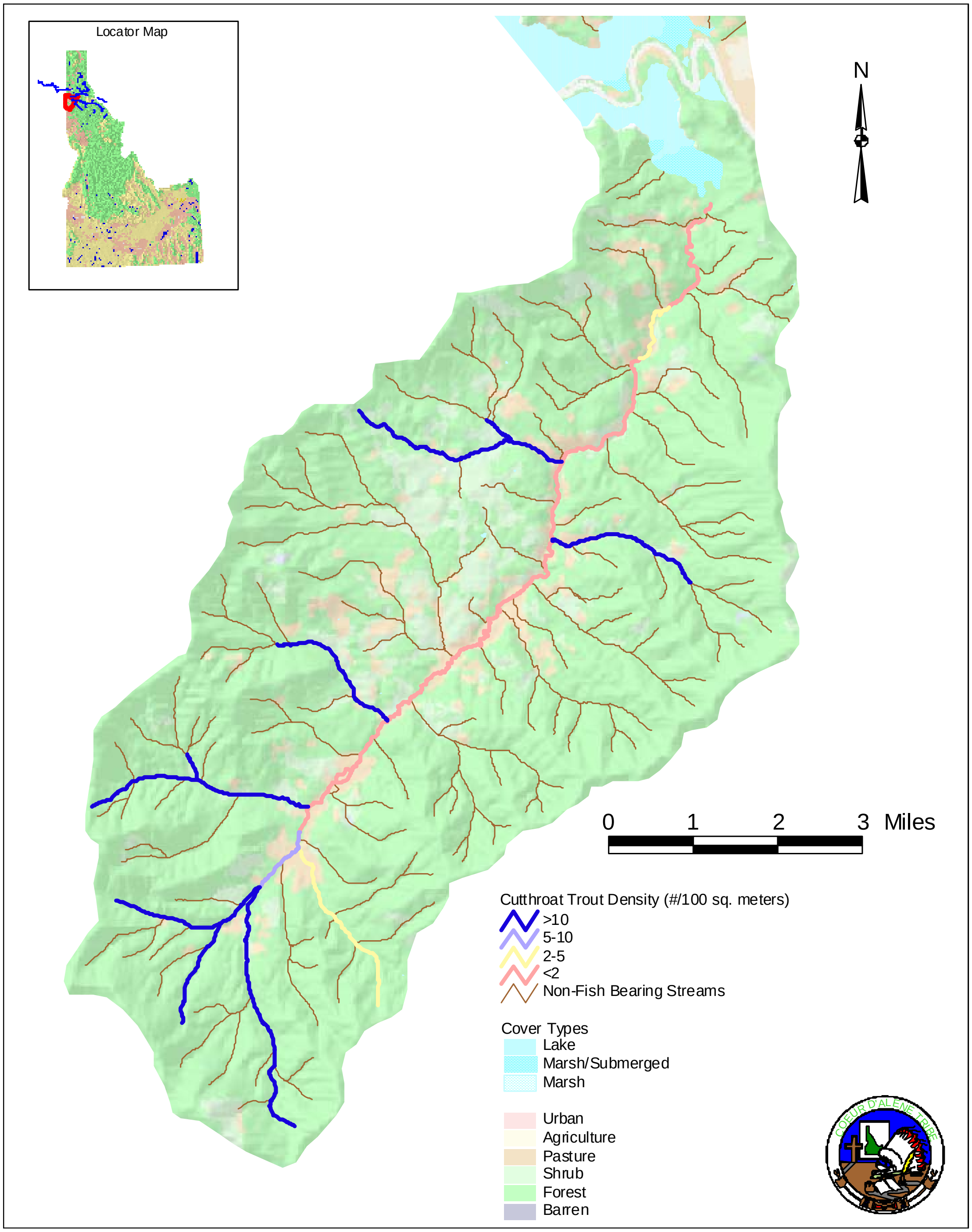


Figure 2.7 Distribution of westslope cutthroat trout in Benewah Creek. Density is reported in number of fish/100 square meters of stream area, with density computed as the average during the three-year period 1996-1998.

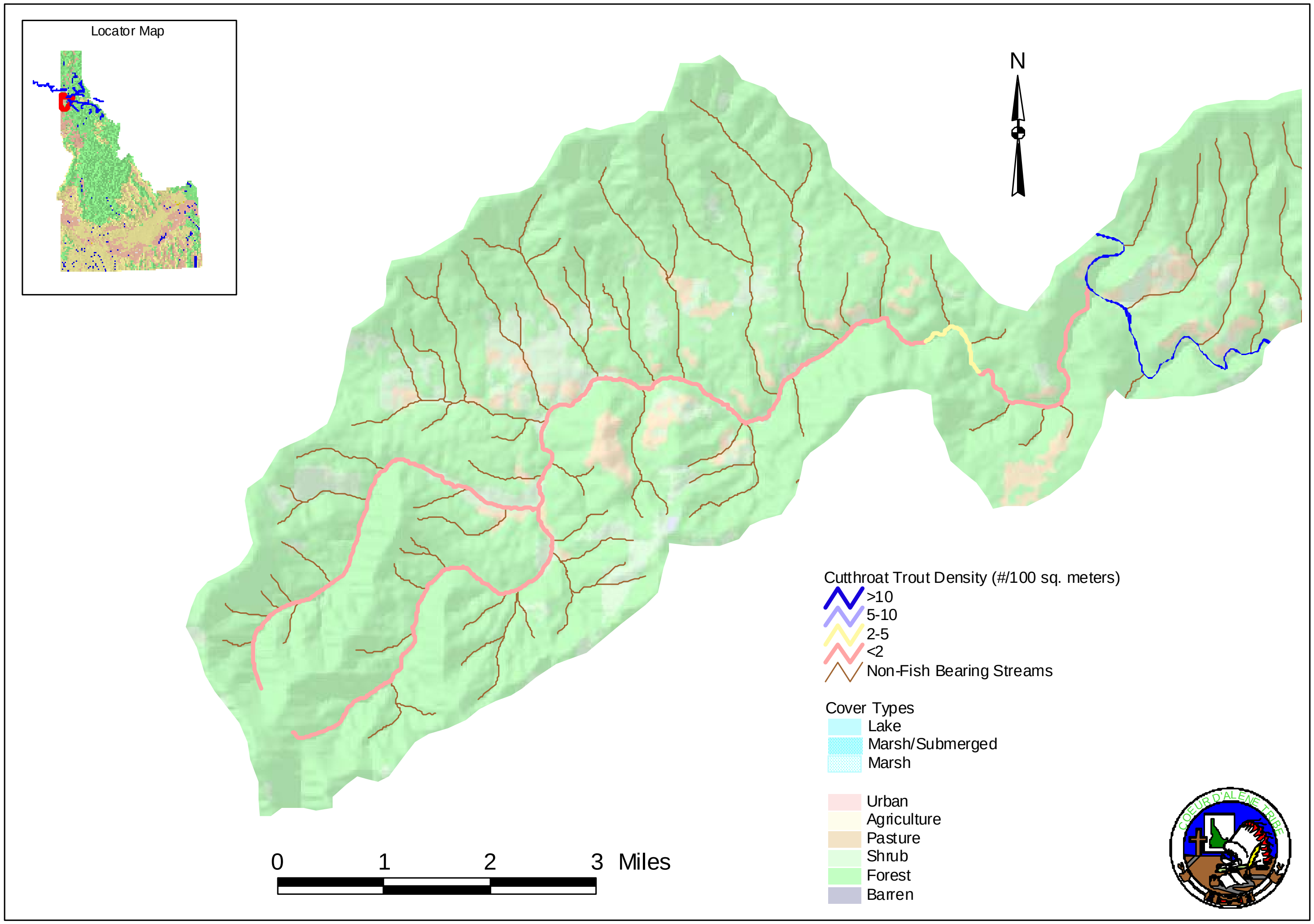


Figure 2.8 Distribution of westslope cutthroat trout in Alder Creek. Density is reported in number of fish/100 square meters of stream area, with density computed as the average during the three-year period 1996-1998.

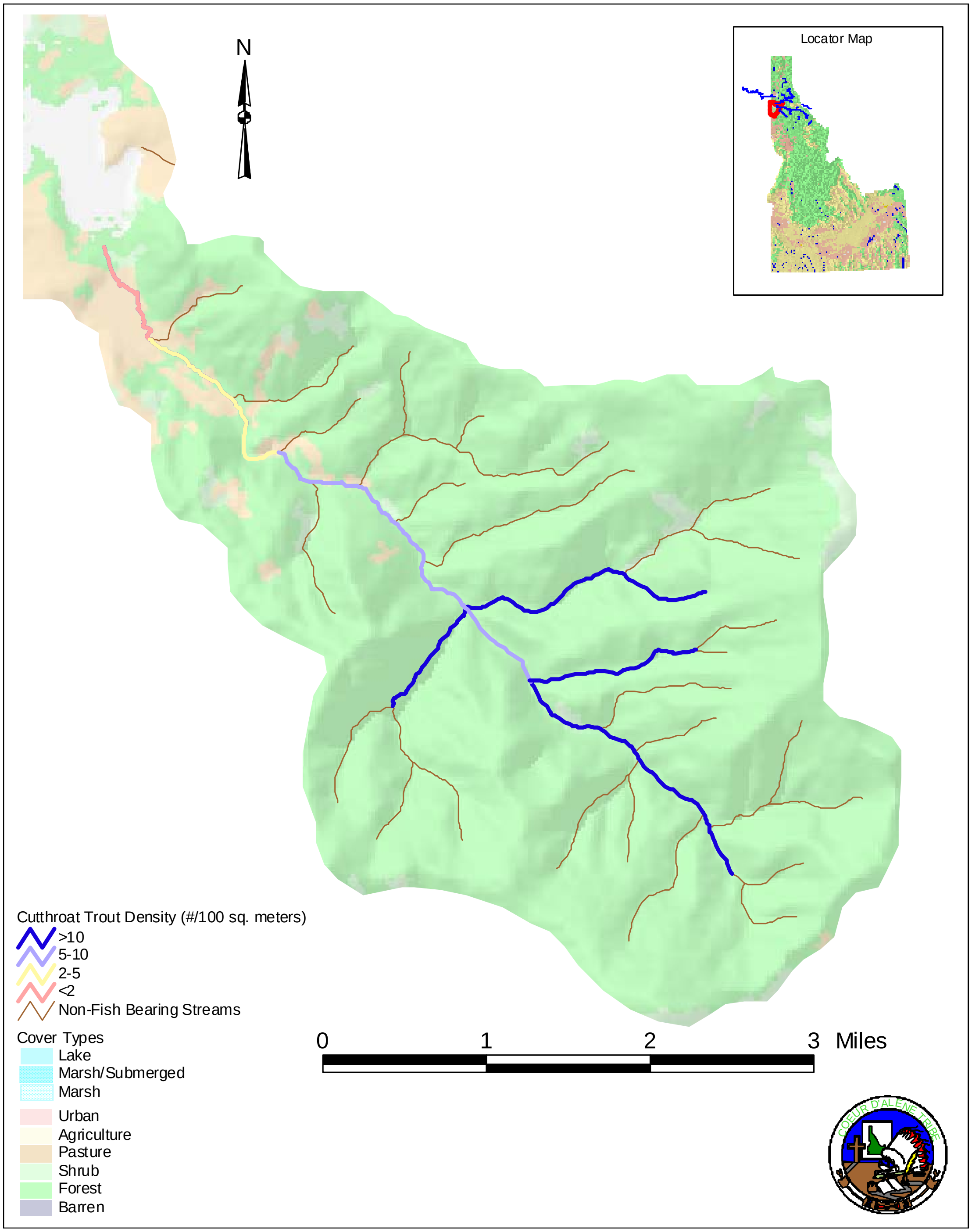


Figure 2.9 Distribution of westslope cutthroat trout in Evans Creek. Density is reported in number of fish/100 square meters of stream area, with density computed as the average during the three-year period 1996-1998.

2.3.3 Limiting Factor Analysis and Recommendations

Past evaluations of stream systems on the Coeur d'Alene Indian Reservation have clearly established the need for implementation of habitat enhancement and restoration projects (Lillengreen et. al., 1993). Initial habitat surveys identified stream reaches in Lake Creek, Benewah Creek, Alder Creek, and Evans Creek that are severely degraded due to past land use practices. Other streams on the Reservation may also be degraded and in need of restoration, however, these drainages have not yet been surveyed.

Limiting factors for target watersheds and recommendations for enhancement are described below, with the limiting factors listed in order of treatment priority. Recommendations for treating limiting factors are presented as a two-phase implementation process. Phase 1 emphasizes passive restoration techniques and entails, 1) changing land use practices that are causing habitat degradation, and 2) reestablishing riparian/stream linkages. Phase 2 involves active manipulations of habitat structure that address site-specific problems which remain following Phase 1 implementation. The ultimate goal is to promote, to the extent feasible, the restoration of natural ecosystem functions and processes.

Lake Creek

- Optimal maximum water temperatures for juvenile and adult life history stages are regularly exceeded in mainstem reaches of Lake Creek. Water temperatures that exceed the lower incipient lethal level for cutthroat trout have also been recorded (Lillengreen et. al., 1993).

  <u>Recommendations</u>: Phase 1) Increase the amount of stream shading through riparian vegetation management. Techniques include, but are not limited to riparian planting, establishing riparian buffer strips, and fencing. Phase 2) Install bank cover and instream structures, where appropriate, which can serve as thermal refugia for trout.

- Optimal base flows for westslope cutthroat trout are rarely achieved due to the inability of the watershed to retain moisture. Late summer stream flows average 10% and 6% of average annual flow for upper and lower Lake Creek, respectively.

  <u>Recommendations</u>: Phase 1) Promote water retention time in upland areas by increasing riparian and upland vegetative cover. Establish riparian buffer strips in forested and non-forested areas. Coordinate upland vegetation management with Tribal Forestry Program managers and private industrial and non-industrial timber landowners. Phase 2) Develop an integrated series of water retention structures that will allow for release of stored water during critical summer rearing periods.

- Severity of some peak flow events has accelerated bedload movement, resulting in increased potential for embryo mortality and reduced spawning success.

  <u>Recommendations</u>: Phase 1) Promote water retention time in upland areas to reduce severity of peak flows. Establish floodplain buffer strips in forested and nonforested areas and reestablish the connections with abandoned or isolated overflow channels. Coordinate upland vegetation management with Tribal Forestry Program managers and private industrial and non-industrial timber landowners. Stabilize stream channels and develop water retention structures where feasible. Phase 2) Implement active bank and streambed stabilization program in high priority areas. Techniques to be used include, but are not limited to bank sloping, construction of natural revetments, and construction of drop structures that encourage gravel retention.

- Cumulative effects of sediment loading has decreased the amount of pool habitat present, which in turn limits overwintering and rearing opportunities for juvenile fish.

Recommendations: Phase 1) Identify sediment sources and reduce input of sediment into stream system. Stabilize source areas through revegetation and use of check or retention structures. Implement BMPs (Best Management Practices) for timber, agriculture, and grazing land uses. Institute monitoring program to evaluate BMP effectiveness. Phase 2) Install instream structures (e.g., bedload drop structures, cross-channel revetments, current deflectors) to create additional pool habitat and off-channel rearing habitat. Consider options for sediment removal or flushing from selected areas after sediment recruitment has been abated.

- Stream lacks habitat diversity and complexity, which limits the natural carrying capacity of stream.

  Recommendations: Phase 1) Create short- and long-term sources of recruitable large woody debris that will naturally improve habitat diversity and complexity. Locate sites within the floodplain where large woody debris can be placed for natural recruitment into the stream channel during flood events. Plant a mix of conifers and hardwoods in riparian areas. Emphasis should be placed on species diversity to ensure continued, long-term sources of wood. Phase 2) Install instream structures (e.g., cross-channel revetments, current deflectors, and half logs where gravels are present) to create additional pool habitat and off-channel rearing habitat, and to enhance instream cover opportunities.

Benewah Creek

- Optimal maximum water temperatures for juvenile and adult life history stages are regularly exceeded in mainstem reaches of Benewah Creek. Summer water temperatures that exceed the lower incipient lethal level for cutthroat trout have also been recorded (Lillengreen et. al., 1993).

  Recommendations: Phase 1) Increase the amount of stream shading through riparian vegetation management. Techniques include, but are not limited to riparian planting, establishing riparian buffer strips, and fencing. Phase 2) Install bank cover and instream structures, where appropriate, which can serve as thermal refugia for trout.

- Optimal base flows for westslope cutthroat trout are rarely achieved. Late summer stream flow averages 10% of average annual flow in mainstem reaches and ranges from 4-10% of average annual flow in the principle tributaries.

  Recommendations: Phase 1) Promote water retention time in upland areas by increasing riparian and upland vegetative cover. Establish floodplain buffer strips in forested and nonforested areas. Coordinate upland vegetation management with the Tribal Forestry Program manager and private industrial and non-industrial timber landowners. Phase 2) Develop water retention structures, where appropriate, that will allow for release of stored water during critical summer rearing periods.

- Severity of some peak flow events has accelerated bedload movement, resulting in increased potential for embryo mortality and reduced spawning success.

  Recommendations: Phase 1) Promote water retention time in upland areas to reduce severity of peak flows. Establish floodplain buffer strips in forested and nonforested areas and reestablish the connections with abandoned or isolated overflow channels. Coordinate upland vegetation management with Tribal Forestry Program managers and private industrial and non-industrial timber landowners. Stabilize stream channels and develop water retention structures where feasible. Phase 2) Implement active bank and streambed stabilization program in high priority areas. Techniques to be used include, but are not limited to bank sloping, construction of natural revetments, and construction of drop structures that encourage gravel retention.

- Stream lacks quality rearing and overwintering habitat for juvenile trout, which limits the natural carrying capacity of stream.

  Recommendations: Phase 1) Increase recruitment potential of large woody debris to naturally improve habitat structure and diversity. Reestablish recruitable sources of woody debris by planting a mix of conifers and hardwoods in riparian areas. Emphasis should be placed on species diversity to ensure continued, long-term sources of wood. Locate sites within the floodplain where large woody debris can be placed for natural recruitment into the stream channel during flood events. Phase 2) Install instream structures (e.g., cross-channel revetments, current deflectors, and half logs where gravels are present) to create additional pool habitat and off-channel rearing habitat, and to enhance instream cover opportunities.

Alder Creek

- Optimal base flows for westslope cutthroat trout are rarely achieved. Late summer stream flow averages 8% of average annual flow for mainstem reaches as well as the principle tributaries.

  Recommendations: Phase 1) Promote water retention time in upland areas by increasing riparian and upland vegetative cover. Establish floodplain buffer strips in forested and nonforested areas. Coordinate upland vegetation management with the Tribal Forestry Program manager and private industrial and non-industrial timber landowners. Monitor beaver activity and document habitat changes. Phase 2) Develop an integrated series of water retention structures that will allow for release of stored water during critical summer rearing periods.

- Migration barrier exists in lower portion of the drainage.

  Recommendations: Phase 1) Manage the lower reaches of Alder Creek for adfluvial cutthroat trout and the upper reaches for resident populations. Discourage private plantings of eastern brook trout.

- Stream lacks deep pool habitat for rearing and overwintering juvenile cutthroat trout.

  Recommendations: Phase 1) Encourage beaver activity that may increase the number of large dammed pools. Phase 2) Install instream structures (e.g., wedge or K-dam structures, cross-channel revetments and current deflectors) to create additional pool habitat.

Evans Creek

- Lower stream reach has severe bank stability problems.

  Recommendations: Phase 1) Encourage proper grazing strategies and reestablish riparian plant communities with dense root masses. Implement riparian fencing program with cooperation of private landholders. Phase 2) Implement active bank and streambed stabilization program in high priority areas. Techniques to be used include, but are not limited to, bank sloping, construction of natural revetments, and rock placement.

2.4 Identifying and Prioritizing Restoration Efforts

Several key steps are essential to the identification and prioritization of rehabilitation efforts on the Coeur d’ Alene Indian Reservation. These steps define a process that guides projects from their inception through implementation, monitoring and evaluation. Coordination with program managers and the Tribal Council is necessary during each step of the planning process to ensure that projects comply with restoration goals and objectives and the management actions of other Natural Resource Department programs. Key steps are identified and described below.

- Identify stream reaches needing some level of enhancement based on physical and biological conditions, and prescribe appropriate restoration techniques. These have generally been completed through the watershed assessment phase and has been summarized in previous sections (section 2.3)

- Prioritize restoration projects using a cost/benefit analysis that considers the potential for long-term ecological recovery and landowner participation.

- Discuss restoration efforts with tribal officials, private landholders, resource managers, and other interested parties, and negotiate landowner agreements.

- Review past data collection efforts for the project site and collect further baseline information, when needed, to facilitate implementation and effectiveness monitoring.

- Develop project specific goals and objectives that are quantifiable and measurable. These objectives should be consistent with overall program objectives and should facilitate the implementation of monitoring and evaluation procedures.

- Coordinate the implementation of projects with the appropriate regulatory agencies and complete all pertinent applications and permits.

- Implement restoration projects using techniques based on the best available science, which will mitigate for factors that limit the productivity of native aquatic communities and enhance the function of ecological processes.

- Begin monitoring and evaluation procedures that will effectively determine project effectiveness as it relates to overall program goals and project specific objectives.

Each of these steps is described in more detail in the following sections.

2.4.1 Prioritizing Restoration Projects

Critical stream habitat areas for cutthroat trout are those that currently provide juvenile rearing and adult spawning opportunities (refer to section 2.3.2 Physical and Biological Assessment of Conditions). These areas are typically 2nd and 3rd order tributaries that contain the least disturbed habitat and encompass the best water quality conditions within their respective watersheds. These areas provide refuge for extant populations that preserve the genetic variability needed to ensure healthy future populations. Critical habitat areas must receive the highest priority for conservation and protection to keep their beneficial characteristics intact. The location and extent of these areas have been defined by comparing specific habitat characteristics (e.g., residual water depth, substrate composition, percent overhead cover, etc.) and water quality parameters, principally maximum summer water temperature, with habitat suitability criteria described by Hickman and Raleigh (1982). Annual population surveys that describe the relative density and distribution of cutthroat trout provide further validation of the importance of these areas.

Underutilized habitat areas in the target drainages generally coincide with riparian habitats that have low or moderate functional value (see section 2.3.2 Riparian and Instream Habitats). This is not surprising considering the important role mature trees play in moderating the effects of temperature and the role of large woody debris in pool formation, gravel retention, and flood control. Many authors have described the function of woody debris in productive trout and salmon habitats (Bjornn and Reiser, 1991; Hicks, et. al., 1991; Platts, 1983; Wesche, et. al., 1985). According to population surveys, underutilized areas comprise much of the mainstem reaches of Lake, Benewah and Alder creeks and warrant restoration treatment of some kind. However, these areas should be assigned priorities for restoration activities in a manner that uses a "top-down" approach. For example, underutilized habitat in close proximity (less than 1 mile) to critical spawning and rearing areas probably represent the best opportunity for increasing the distribution of cutthroat trout in the near term (within 10 years) and should be treated before areas located further downstream.

Several questions have been developed to facilitate a valid ranking process for restoration projects. These questions encompass assumptions related to the biological assessment of biotic and abiotic factors, the cost/benefit ratio of proposed restoration, and the potential for sustaining long-term monitoring and evaluation efforts based on landowner cooperation. Projects proposed under the restoration program would be prioritized based on their ability to resolve these questions, in addition to satisfying site specific biological objectives that reflect the goals of the restoration program. Important questions are stated as follows:

1) Have watershed assessments and limiting factor analysis been completed prior to implementing stream enhancement measures? Is further evaluation necessitated prior to implementation?

2) Is the proposed project located in a stream reach that has been identified as a "critical" treatment area (See sections 2.3.2)? What is the project's location in relation to critical spawning and rearing areas?

3) How will the proposed enhancement measures mitigate factors that limit biological productivity? What is the site specific potential for enhancement?

4) What are the costs of the proposed enhancement measures? Are the costs justified based on the potential for enhancement?

5) What level of commitment to restoration efforts has been demonstrated by the cooperating landowner? What is the potential for sustaining long-term benefits based on the landowner agreement?

2.4.2 Landowner Agreements

The success or failure of stream restoration efforts will, in large part, be measured by the participation of private landowners and their long-term commitment to providing quality fish and wildlife habitat. Property rights is a sensitive issue, so it is a goal of the Coeur d' Alene Tribe Fish, Water and Wildlife Program to introduce stream restoration efforts as an opportunity for landowners, rather than an imposition of regulation. Furthermore, it is the job of Fish, Water and Wildlife personnel to provide information regarding management opportunities, restoration benefits, and voluntary approaches, which will lead to healthier watersheds. It will be important for landowners to feel empowered when faced with the decision of how their management operations can accommodate restoration efforts. Options for management which are endorsed by the Fish and Wildlife Program should be flexible enough to satisfy landowner concerns, while providing the maximum foreseeable benefit to native fishes and their habitats.

One example of a management option involves the joint development of a grazing rotation plan for a riparian corridor. Such a plan may require temporary cessation of grazing to allow reestablishment and/or recovery of native vegetation. Resumption of controlled grazing could follow the recovery period, with the understanding that conditions such as soil productivity, natural cycles of seed development and dispersal, long-term stabilization of water temperature, and bank stability should determine the maximum allowable grazing pressure. Local county soil surveys, published by the USDA Natural Resource

Conservation Service (Weisel 1980; 1981), provide valuable information on soil properties and classification, yields per acre of pasture, and woodland management and productivity, and can be used as a general guideline for determining allowable grazing pressure.

A generalized landowner agreement has been developed with these issues in mind. The agreement creates a legal foundation that establishes the commitments of the landowner and the Coeur d' Alene Tribe Natural Resource Department and addresses liability issues. The agreement is accompanied by several exhibits that specifically identify the location of the project and define the work to be accomplished. The terms of the agreement are flexible, but should be long reaching enough to ensure that monitoring and evaluation procedures can be completed. These agreements, as a general rule, have the general characteristics of long term conservation easements that are tied to the land not the landowner.

A landowner agreement, currently in effect for a riparian restoration project, is included as Appendix B to illustrate the components of a generalized legal agreement.

2.4.3 Pre-Implementation Evaluations

Pre-work evaluations often serve as the first step towards establishing an implementation project. The intent of the evaluations is to capture much of the temporal variability of the project site in question, and to establish a database for project planning and monitoring. The required intensity of the evaluation will depend, to a large extent, on the availability and character of data for the project site. A thorough review of data and the measurement techniques used to collect that data should be completed to determine whether they will be appropriate to monitor management applications and evaluate project effectiveness (see Section 2.7 - Monitoring and Evaluation). This assessment must be completed prior to implementing restoration projects. Watershed assessment data should be used as the basis for the evaluation when feasible, however, these data may be too generalized to provide the basis for evaluating site specific changes in certain parameters, such as stream shade or riparian plant density.

If past data are unavailable or insufficient to provide the basis for baseline characterization, several options are available, including selection of reference sites or establishment of permanent photo points.

Change resulting from management activities is often assessed through comparisons to reference sites. One advantage of this approach is that this often leads to greater flexibility in the selection of both the monitoring parameters and the sampling locations. Several key sampling procedures should be taken into consideration if control sites are used during monitoring. These include:

- Control and sample sites should be at least 100 meters in length, if possible.
- The control and treatment sites should be the same size and have the same stream gradient.
- Control sites should be both physically and biologically similar to the site that will be managed.
- If only one control site is used, it should be located upstream from the treatment site. If the control site must be in another stream, the streams should be similar or the differences should be well documented in advance of any management changes or monitoring activities.
- Sampling should be conducted at similar times for each site and year. High and low water conditions have profound impacts on the physical and biological environment, so these conditions must be accounted for.

Another option is to thoroughly photo document site conditions prior to implementation. Establishing fixed photo points that are revisited annually will often provide sufficient documentation of change when coordinated with simple quantitative measures. This is particularly effective in demonstrating changes in riparian condition.

Platts and others (1987) provide a compilation of the latest methods for use in managing, evaluating, and monitoring riparian conditions adjacent to streams. This document will prove useful in selecting appropriate measures for baseline evaluations. Regardless of the method(s) to be used, selection of new measurement techniques for an undocumented site will necessitate a thorough understanding of project specific objectives.

2.4.4 Identifying Project Specific Goals and Objectives

Once specific projects have been ranked and baseline information is compiled, the next step is to formulate the project specific goals and objectives. This process requires the participation of both the managers and the technical staff in order to ensure that the specific objectives are technically and financially feasible.

Careful identification of the specific objectives probably is the most crucial step in the entire planning process, as a set of precise objectives will largely define the remainder of the monitoring project, including the approximate cost, monitoring parameters, sampling locations, sampling frequency, and data analysis techniques.

When objectives are specified, they must be stated in quantifiable and measurable terms; this is of paramount importance. An example of a specific objective could be to increase the density of shrubs from 25 to 50 percent within a treatment reach. This specifically requires that existing conditions be documented for comparison with future management results.

Defining a time frame in which the expected change is to occur is equally important. In the above example, a realistic time frame must take into account site specific conditions, such as, soil type, moisture regime, interspecific competition, expected land use patterns, and the age and vigor of plantings. Identifying specific objectives will, in turn, implicitly define appropriate monitoring and evaluation techniques.

Comparison of current habitat conditions to optimal westslope cutthroat trout habitat conditions can be used as a planning tool for identifying site specific habitat objectives. This must be done carefully, however, because site potential will vary because of several variables, including rainfall patterns, soil type, landform, and history of use.

Several additional sources of information are available in the scientific literature to aid in identifying realistic project objectives. Information on planting techniques and considerations for riparian rehabilitation are described by several authors (Hoag, 1992; Hoag and Short, 1993; Van Haveren and Jackson, 1986; USDA, 1981). In addition, a large body of information documents the evaluation of habitat modifications and their effect on fish distribution, relative abundance, and habitat utilization (Hamilton, 1989; Kauffman et. al., 1993; Radko and Overton, 1992; Reeves and Roelofs, 1982; Reeves et. al. 1990; Hunt, 1988).

2.4.5 Coordination and Permitting

Several permitting processes must be satisfied prior to on-site implementation. These may include obtaining a section 404 permit for discharge of dredged of fill material into waters of the United States, receiving cultural resource clearance in compliance with section 106 of the National Historic Preservation Act, and complying with mandated protections for species listed under the Endangered Species Act.

Clean Water Act

The U.S. Army Corps of Engineers was granted regulation over public waterways in 1899 with the passage of the River and Harbor Act. The Corps of Engineers regulatory program was further expanded when Congress passes the Federal Water Pollution Control Act Amendments of 1972. Section 404 of the Act established a permit program to be administered by the Corps to regulate discharges of dredged or fill material into waters of the United States.

Discharge of fill material generally includes, but is not limited to, the following activities: placement of fill that is necessary to the construction of any structure or impoundment requiring rock, sand or dirt, or other material for its construction; site development fills for recreational, industrial, commercial, residential and other uses; causeways or road fills; dams and dikes; artificial islands; property protection and/or reclamation devices such as riprap, groins, seawalls, breakwaters, and revetments; beach nourishment; levees; fill for intake and outfall pipes usually associated with power plants and underwater utility lines; fill associated with the creation of ponds and any other work involving the discharge of fill material. A permit is required whether the work is permanent or temporary.

Several of these regulated activities involving section 404 of the Clean Water Act will be employed during the implementation of the Coeur d'Alene Tribe's Stream Restoration Program. The Coeur d'Alene Tribe works directly with the local office of the U.S. Army Corps of Engineers to obtain Section 404 permits. Applications for the permits should be submitted as early in the planning process as possible. The permit review process normally takes approximately 60 days after a completed application is received. An example of a completed Section 404 permit has been included as Appendix C**.**

National Historic Preservation Act

Since stream corridors have been a powerful magnet for human settlement throughout history, it is not uncommon for historic and prehistoric resources to be buried by sediment or obscured by vegetation along stream corridors. Prior to implementation, any potential cultural resources should be identified in compliance with section 106 of the National Historic Preservation Act. An archaeological record search should be conducted during the planning process in accordance with the State Historic Preservation Officer (SHPO) and with the Tribal Cultural Resources Committee.

If a site is uncovered unexpectedly, all activity that might adversely affect the historic property must cease, and the responsible agency official must notify the USDI National Park Service, the SHPO, and the Tribal Cultural Resource Liaison. Upon notification, the SHPO determines whether the activity will cause an irreparable loss or degradation of significant data. This might require on-site consultation with a 48-hour response time for determining significance and appropriate mitigation actions so as not to delay implementation activities inordinately.

If the property is determined not to be significant or the action will not be adverse, implementation activities may continue after documenting consultation findings. If the resource is significant and the on-site activity is determined to be an adverse action that cannot be avoided, implementation activities are delayed until appropriate actions can be taken (i.e., detailed survey, recovery, protection, or preservation of the cultural resources).

Endangered Species Act

There are several consultation, or conference, requirements for federal agencies specific to sections 7(a) and 7(c) of the Endangered Species Act (ESA). Agency responsibilities under section 7(a) of the ESA requires:

1. Federal agencies to utilize their authorities to carry out programs to conserve endangered and threatened species;
2. Consultation with the US Fish and Wildlife Service (FWS) when a Federal action may affect a listed endangered or threatened species to insure that any action authorized, funded or carried out by a Federal agency is not likely to jeopardize the continued existence of listed species; or result in destruction or adverse modification of critical habitat. The process is initiated by the Federal agency after determining the action may affect a listed species; and
3. Conference with FWS when a Federal action is likely to jeopardize the continued existence of a proposed species or result in destruction or adverse modification of proposed critical habitat.

Section 7(c) of ESA requires Federal agencies or their designees to prepare Biological Assessment (BA) for major construction activities. A major construction activity is a construction project or other undertaking having similar physical impacts, which is a major action significantly affecting the quality of human environment as referred to in the NEPA (42 U.S.C. 4332 (2)(c). The BA analyzes the effects of the action on listed and proposed species. Effects of the action refers to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action.

The process begins with a Federal agency in requesting from FWS a list of proposed and listed threatened and endangered species. If the BA is not initiated within 90 days of receipt of the species list, the accuracy of the species list should be informally verified with the Service. The BA should be completed within 180 days after its initiation (or within such a time period as is mutually agreeable). No irreversible commitment of resources is to be made during the BA process, which would foreclose reasonable and prudent alternatives to protect endangered species. Planning, design, and administrative actions may be taken, however, no construction may begin during this period.

The FWS recommends the following for inclusion in the BA; an onsite inspection of the area to be affected by the proposal which may include a detailed survey of the area to determine if the species are present; a review of literature and scientific data to determine species distribution, habitat needs and other biological requirements; interviews with experts, including those within FWS, state conservation departments, universities and others who may have data not yet published in scientific literature; an analysis of the effects of the proposal on the species in terms of individuals and populations, including consideration of cumulative effects of the proposal on the species and its habitat; and an analysis of alternative actions considered. The BA should document the results, including a discussion of study methods used, any problems encountered, and other relevant information. The BA should conclude whether or not a listed or proposed species will be affected. Upon completion, the BA should be forwarded to the local FWS office.

2.4.6 Project Implementation - Description of Restoration Techniques

General descriptions of active restoration techniques used to beneficially manipulate biotic and abiotic factors that influence the number and size of trout in streams are located in Appendix D. Only a limited number of techniques by broad category are shown as examples. Neither the number of examples nor their descriptions are intended to be exhaustive. The examples are conceptual and contain little design guidance. All restoration techniques, however, should be designed; often through an interdisciplinary approach. Limited guidance is provided on applications, but local standards, criteria, and specifications should always be used.

These and other techniques have specific ranges of applicability in terms of physical and climate adaptation. Techniques that are selected must be components of a system designed to restore specific functions and values to the stream corridor. The use of any single technique, without consideration of system functions and values, may become a short-lived, ineffective fix laid on a system-wide problem. All restoration techniques are most effective when included as an integral part of a restoration plan. Typically a combination of techniques are prescribed to address prevailing conditions and desired goals. Effective restoration will respond to goals and objectives that are determined locally through the planning process described in Sections 2.4.1 through 2.4.6.

The restoration plan may prescribe a variety of approaches depending on the condition of the stream corridor and the restoration goals:

- *No action (Passive Restoration).* Simply remove disturbance factors and let nature heal itself.
- *Management (Passive Restoration).* Modify disturbance factors to allow continued use of the corridor, while the system recovers.
- *Manipulation (Active Restoration).* Change watershed, corridor, or stream conditions through land use changes, intervention, and designed systems ranging from installing practices to altering flow conditions, to changing stream morphology and alignment.

Regardless of the techniques applied, they should restore the desired functions and achieve the goals of the restoration plan. The following are general considerations that apply to many or all of the techniques listed in the appendix:

- The potential adverse impacts from failure of these and other techniques should be assessed before they are used.
- Techniques that change the channel slope or cross section have a high potential for causing channel instability upstream and downstream. They should therefore by analyzed and designed by an interdisciplinary team of professionals. These techniques include: weirs, sills, grade control measures, channel realignments, and meander reconstruction.
- The potential impact on flood elevation should be analyzed before these and other techniques are used.
- Many techniques will not endure on streams subject to headcuts or general bed degradation.
- Some form of toe protection will be required for many bank treatment techniques to endure where scour of the streambank toe is anticipated.
- Any restoration technique installed in or in contact with streams, wetlands, floodplains, or other water bodies are subject to various federal and tribal regulatory programs and requirements. Most techniques presented in the appendix would require the issuance of permits prior to installation.

Section 3.0

Interim Harvest Opportunities

3.1 Introduction/Purpose and Need

Since harvest of fish remains an ongoing subsistence activity for many Tribal members, there is a need to reduce fishing pressure while giving restoration efforts a chance to benefit the ecosystem. Accordingly, this section addresses a plan to satisfy cultural objectives while affecting restoration of resident fish population in Coeur d'Alene Lake, and rivers and streams of the Coeur d'Alene Reservation. This will be accomplished by creating and stocking a number of isolated ponds near population centers and traditional fishing areas on the Reservation. This "put and take" fishery will create interim harvest opportunities for Tribal members while the resident species populations stabilize and rebound from their depleted state.

To help determine the number of ponds needed to satisfy fishing demand, a pilot project was implemented in which Worley Pond was stocked with 1000 rainbow trout in 1995. Fishing was limited to children under the age of 12, senior citizens, and all enrolled Coeur d' Alene Tribal Members. Creel surveys were conducted starting June 1, 1995 and ending August 23, 1995. Fishing pressure was most intense just after the pond was opened for fishing. As angler success declined so did the effort. It appears that as long as catch rates are up demand is high. The creel data was summarized and 159 anglers caught 410 fish. The pond was open to fishing for 1008 hours during the sample period. Fish and wildlife personnel conducted creel samples for 408 of those hours or 40.5 % of the available fishing time. Therefore, it can be assumed that 40.5% of the fisherman were sampled and 410 fish equated to 40.5 % of the catch. Thus, total catch for the season was estimated to be 1012 fish or all of the available fish. In 1996, 2900 fish were released into Worley Pond and an estimated 100 fish a day were caught over the next 22 days. On several occasions 30 individual anglers were observed at one time.

The Worley pond "experiment" demonstrated that there is sufficient demand within the area to construct more ponds. Providing more fish for harvest in diverse settings will reduce pressure in critical areas. This program will allow subsistence while protecting native species on the Reservation.

Interim harvest opportunities will consist of a "put and take" fishery located at several sites within the Reservation boundaries. Typically a "put and take" fishery is defined as one where fish are provided for the sole purpose of harvest. As it is used in this case it is where hatchery fish are provided as an alternative harvest base to promote the recovery of resident wild fish in selected rivers and streams. Estimates indicate that at least five ponds should be developed within the next three years. Management of all the ponds will be based on location, accessibility, suitability for salmonid species, and cost. To minimize the impact on existing native fish stocks, development of ponds will be isolated from the rivers and streams on the Reservation. Project objectives are:

- Provide harvest opportunities on the Reservation to give restoration efforts a chance to take hold and provide protection of depressed westslope cutthroat trout populations.
- Provide suitable sites in diverse settings where the tribal community may develop a subsistence fishery.

3.2 Pond Program Implementation

Over the last several years, poor fishing conditions have severely limited the ability of the Tribal Community to harvest desirable fish species in any acceptable numbers. The reasons for this condition have been previously stated. The Coeur d' Alene Tribe has made the difficult decision to maintain a strict wild fish management policy for traditional fishing areas, primarily important cutthroat trout streams on the Reservation. The emphasis is to restore these areas in order to optimize conditions for expansion of wild stocks (restoration of habitat). However, substantial increases to these populations to support any sizable harvest goals are not expected for some time and may require supplementation to rebuild these stocks.

Since the Coeur d'Alene decided to close streams to harvest in sensitive drainages on the Reservation as the principal method of protecting and promoting wild stock expansion, a hatchery oriented "put and take" fisheries program was implemented. To provide for reasonable harvest of desired species in the near future it was decided that a series of trout fishing ponds located in strategic areas would best serve the need for an alternative fishery on an interim basis. To protect the integrity of the wild fish restoration projects none of these ponds would be placed in drainages where restoration is occurring. This will minimize the chance of interaction between hatchery and native fish species. Additionally, all ponds would be closed basin fisheries to prevent genetic introgression as well as spread of disease.

A minimum of five ponds will be developed over the next three years. One pond (Worley pond) is currently operational, 2 ponds will be completed during FY99 and 2 ponds will be completed during FY00. Potential pond sites will be submitted to other Natural Resource Programs, the Natural Resources Committee, the Planning Department, and the Tribal Council for review, coordination and final approval

Duration of the program will be dependent on other aspects of the overall program. Since these ponds are intended to relieve pressure from weak stocks in the area, alternative fisheries will be maintained until population of weak stocks are determined to be able to withstand previously stated harvest goals. If it is determined through monitoring that the current pond program is not reliving fishing pressure on weak stocks, alternative measures will be explored to meet program objectives.

3.2.1 Desired Species and Stocking Strategy

Rainbow trout are the preferred species for stocking because the species has one of the highest temperature tolerances (25.5^{o}C) of the salmonid family (Piper et. al. 1982, Miko et. al. 1995), large numbers are produced by federal, state, and private hatcheries, and they are readily available and usually can be delivered on demand.

The primary management goal to determine stocking strategy will be angler satisfaction and success. Angler satisfaction and success is directly correlated to catch and/or harvest rates and fishing effort. Mean catch rates necessary to achieve an excellent fishing success rating would be around 2.88 fish/hour (Miko et. al. 1995). This would be stocking densities of about 12,000 fish/ha. However, researchers have shown that mean catch rates peak at about 0.6-0.7 fish/hour, and catch rates needed for angler satisfaction (trip satisfaction) ratings to be considered excellent are much lower. Weithman and Katti 1979, Hicks et. al. 1983, and Miko et. al. 1995 have shown that stocking densities around 1400 fish/ha will provide good to excellent angler satisfaction ratings, and that anglers would be satisfied with their trip quality even if they were dissatisfied with their fishing success. The management strategy employed by the Coeur d'Alene Tribe will be to provide fish catch rates of about 0.5 fish/hour. This is a conservative management strategy, since averages of 1.0 fish/hour at the Worley pond are currently being achieved.

3.2.2 Site Selection

Site selection for the proposed fishponds is a very important part of the pond planning process. The following criteria will be used to determine pond locations:

- The potential site is located near a population center to provide accessibility of the Tribal Communities
- The pond should be constructed on tribal ground. However, if all the other construction conditions are met then purchase of the site should be considered.
- A water source needs to be identified and developed

3.2.3 Trout Pond Design

Once the general locations of the ponds have been determined and the water source has been identified, the exact location, size, and shape of the pond will be determined. All the necessary details for completion of the pond will be worked out in this phase of the planning process. The following steps will outline the procedures for planning the construction of the pond.

I.) A drawing of the pond including depths, contours, and shape will be completed. Detailed drawings of the water inflow, outflow, and retention structures will also be included. The design will be consistent with standard trout pond construction guidelines of the Natural Resource Conservation Service.

II.) Necessary permits will be applied for. If wetland habitat is being disturbed some mitigation under section 404 may be required before a permit for construction will be issued. Considerable attention will be given to habitat improvements (i.e. shoreline contours, grade and shape banks, tree brush and grass landscaping, location of primary fishing sites around the pond, and develop pathways around the pond).

III.) The following items will also be addressed in the final design proposal:
  - i.) access road and parking development,
  - ii.) shoreline degradation and erosion potential, and
  - iii.) fish planting problems (getting fish truck near enough to the shore for planting).

Upon completion of the above steps, the design will be submitted to the Coeur d'Alene Tribe's Natural Resource Committee and Tribal Council for approval. The proposal will then be submitted to BPA to complete NEPA. Once all steps have been completed construction will begin

3.2.4 Pond Construction

Once the approved plan has been obtained the following procedures will be used to complete the construction phase:

a.) Request for Bids
Three bids will be requested and the contract will be let to the lowest eligible bidder.

b.) Let contract and begin construction
Fish and Wildlife will provide personnel in the event that extra help is needed. Fish and Wildlife personnel will oversee all phases of construction.

c.) Inspect completed construction and approve final product
Items which will be addressed are:
  - Completeness of shoreline development
  - Dam stability
  - Water leakage
  - Construction Cleanup

Only after a complete inspection of the work will payment for services be rendered.

d.) Complete landscaping and riparian plantings
Fish and wildlife personnel will use acceptable best management practices in revegetating the shoreline riparian area. Only native plants will be used, in order to provide maximum fish and wildlife benefits.

e.) Approve pond for planting of fish
Once all the above items have been completed the pond will be approved for planting of fish. Fish will be planted according to the procedures outlined in this section

3.2.5 Pond Development and Management Plan

Specific trout pond management plans will be developed concurrently with construction. The plans will address total number of fish per pond and the planting schedule.

The total number of fish needed for each of the ponds will be determined at the start of each fiscal year. The source of fish will also be determined. Currently, we are relying on the Dworshak hatchery for needed fish for Worley pond. It is anticipated that upon construction of the Coeur d'Alene Tribal Fish Hatchery, fish will be secured from our own hatchery.

A schedule for planting of fish into each of the ponds will be completed. Each pond will be planted at least once a year. The number and size of the plantings for each individual pond will be determined by past use, and anticipated fishing pressure for the upcoming season.

The number of fish needed and the timing of the plantings for each pond will be determined by the following factors: The maximum number of fish each pond can hold, the ability of the pond to sustain a population without food supplementation, and the expected rate of removal. This will be determined using methods developed for hatcheries and trout farm ponds (Piper et. al. 1982).

Section 4.0

Public Involvement and Education

4.1. Introduction/Purpose and Need

The integration of social and cultural values inherent to a community is essential to the long-term success of a management plan. If this is not accomplished, it is likely that the management plan will fail. The public wants to be involved in the resolution of environmental issues and wants to be heard and counted in the decisions about land and resource use. Residents of the Reservation's watersheds are a part of the ecosystem and should share a common goal with the Fish, Water and Wildlife Program. Just as cumulative effects have led to the degradation of many watersheds, it will take the cumulative contribution of landowners, the public and professionals to restore natural habitats and processes.

There are many reasons for a public involvement process. Some include:

1. It satisfies an essential information need. As local communities become better informed of the issues affecting them, their feelings of security increase and subsequently they are more willing to affect change that benefits common good and the good of the ecosystem.
2. It satisfies a need for involvement. It helps satisfy the publics' concern that their values related to the watershed are recognized, and addressed through a cooperative process
3. It identifies the individual interest. The public needs to know "what's in it for me" or they have little stake or interest in the outcome of the plan.
4. It creates opportunities for cooperation and empowers the individuals engaged in the process. Shared responsibilities must rely on shared knowledge and a commitment to formulate solutions collectively.
5. It creates opportunities for public ownership. The members of the community need to be involved, and understand process before they can support the action and the expected results.

In order to increase the public's awareness of the Coeur d'Alene Tribe's Fisheries Restoration Program and to involve the Reservation community and affected parties in a meaningful public involvement and education process, the following goals and objectives have been identified:

1. Encourage landowner and public support and guidance in the identification of creative solutions to land use problems impacting fisheries habitat in the study drainages.
2. Develop and coordinate landowner, community and agency coalitions that will address issues related to habitat restoration efforts.
3. Develop and distribute educational literature on fish habitat restoration.
4. Develop and implement an outreach effort for all interested parties, including special interest groups, schools, and agencies.
5. Develop educational components to be utilized by the local schools, clubs (i.e.4-H), community groups, etc.

4.2 Approach to Public Involvement and Education

Two parallel processes will be designed. One process will focus on addressing methods of fostering landowner cooperation and modifying land use practices that impact fisheries habitat. The second process will focus on promoting the general public's awareness of fish habitat and watershed health issues and increasing the public's awareness of the Coeur d'Alene Tribes compensatory harvest program.

Formulation of watershed working groups will be comprised of local land-owners, special interest groups (primarily active sportsman groups in the local watersheds), and interested agencies. The watershed working groups will be responsible for assisting in the identification of problems in the watershed and developing long-term methods of improving fisheries habitat. These working groups will also be responsible for gaining public support and cooperation with the restoration program. The watershed groups will help identify and solicit other sources of revenue to expand the restoration effort.

The second process will involve a "public relations" campaign or "marketing program". This process will focus on educating the general public of the importance of fish habitat and watershed health issues. This campaign will target civic organizations, local schools, the general public and other interested parties. The educational campaign will also prepare and give presentations pertaining to the needs of and protection of fisheries habitat. Field trips to showcase restoration projects and a quarterly newsletter will be published and distributed.

Section 5.0

Supplementation Opportunities for the Coeur d' Alene Indian Reservation

5.1. Introduction

Recent declines in native salmonid fish populations, particularly westslope cutthroat trout and bull trout (*Salvelinus confluentus*), in the Coeur d' Alene basin have been the focus of study by the Coeur d' Alene Fish, Water, and Wildlife program since 1990. In fact, early studies on Coeur d'Alene Lake showed that significant declines had occurred as early as 1932. It appears that there are a number of factors that contributed to the decline of resident fish stocks within Coeur d'Alene Lake and its tributaries (Ellis 1932; Oien 1957; Mallet 1968; Scholz et. al. 1985, Lillengreen et. al. 1993). These factors include: construction of Post Falls Dam in 1906; major changes in land cover types from primarily forested areas to forests with recent and recovering clearcuts, agricultural and pasture lands, urban development, mining and open range land; and introduction of exotic fish species.

Over 100 years of mining activities in the Silver Valley have had devastating effects on the quality of the water in the Coeur d'Alene River drainage and Coeur d'Alene Lake. Effluent from tailings and mining waste have contributed vast quantities of trace heavy metals to the system. Poor agricultural and forest practices have also contributed to the degradation of water quality and habitat suitability for resident salmonids. Increased sediment loads from agricultural runoff and recent and recovering clearcuts, and increases in water temperature due riparian canopy removal may be two of the most important problems currently affecting westslope cutthroat trout. Increases in water temperature have reduced the range of resident salmonids to a fraction of its historic extent. Within this new range, sediment has reduced the quality of both spawning and rearing habitats. Historically, municipal waste contributed large quantities of phosphates and nitrogen that accelerated the eutrophication process in Coeur d'Alene Lake. However, over the last 25 years work has been completed to reduce the annual load of these materials. Wastewater treatment facilities have been established near all major municipalities in and around the basin.

Species interactions with introduced exotics as well as native species are also acting to limit cutthroat trout populations. Two mechanisms are probably at work: interspecific competition, and species replacement. Competition occurs when two species utilize common resources, the supply of which is short; or if the resources are not in short supply, they harm each other in the process of seeking these resources. Replacement occurs when some environmental or anthropogenic change (e.g., habitat degradation, fishing pressure, etc.) causes the decline or elimination of one species and another species, either native or introduced, fills the void left by the other.

Within their historic range, cutthroat trout evolved with few other fish species. Thus they developed as "generalists" and are more susceptible to interspecific interactions than other fish which evolved in the presence of multiple species (Griffith, 1988). In the Coeur d'Alene basin, it is most likely that environmental conditions, rather than competition through interspecific interactions, shaped cutthroat trout behavior and morphology. Rapid changing environmental conditions in the Coeur d'Alene Basin has allowed introduced exotics, and native species other than cutthroat trout to proliferate. This has been shown to be true in the Columbia River system where dam construction has altered the fish species composition and allowed the northern pikeminnow (*Ptychocheilus oregonensis* Richardson) to effectively reduce the numbers of juvenile salmon migrating downstream (Beamesderfer and Rieman 1991).

There are twenty-one identified species of fish inhabiting the Coeur d'Alene Lake study area, of which only seven are indigenous species. The indigenous species are cutthroat trout, bull trout, northern pikeminnow, largescale sucker (*Catostomus macrocheilus* Girard), longnose sucker (*Catostomus*

catostomus Forster), mountain whitefish (*Prosopium williamsoni* Girard), and sculpin (*Cottus* sp.). The introduced exotic species include yellow perch (*Perca flavescens* Mitchill), pumpkinseed sunfish (*Lepomis gibbosus* Rafinesque), largemouth bass (*Micropterus salmoides* Lacepede), black crappie (*Pomoxis nigromaculatus* Lesuerur), brown bullhead catfish (*Ictalurus neblosus* Lesuerur), black bullhead catfish (*Ictalurus melas* Rafinesque), channel catfish (*Ictalurus punctatus* Rafinesque), tench (*Tinca tinca* Linnaeus), pike (*Esox lucius* Linnaeus), kokanee salmon (*Oncorhynchus nerka* Walbaum), chinook salmon (*Oncorhynchus tshawytscha* Walbaum), smallmouth bass (*Micropterus dolomieui* Lacepede), rainbow trout (*Oncorhynchus mykiss*), and lake superior whitefish (*Coregonis clupeaformis* Mitchell). The Idaho Department of Fish and Game has been stocking and/or managing for exotic species, most notably northern pike, chinook salmon, and kokanee salmon, in Coeur d'Alene Lake for over 50 years. Other studies have indicated that most of these species can competitively exclude or replace cutthroat trout in both stream and lake environments (Griffith, 1972, 1974, 1988; Moyle and Vondracek, 1985; and Marnell, 1986, 1987, 1988).

Westslope cutthroat trout exhibit three primary life history forms: adfluvial, fluvial, and resident. Of these forms, adfluvial production is considered the most important in the Coeur d' Alene basin. The reasons for this are that they attain the largest size and played an important role in the subsistence economy of the Coeur d'Alene Tribe. Adfluvial salmonids move through many different habitats during their life history, thus production is governed by a wide variety of physical, chemical, and biological influences. In particular, they differ from the other forms in that they are dependent on both the tributary and lake environments for completion of their life cycle. Because of this dependency on multiple habitats, they are more sensitive to widespread changes in habitat quality and complexity than the other forms. Furthermore, the maximum potential for interaction with introduced exotic species is realized in the adfluvial life history strategies of the westslope cutthroat trout. During the course of their lifecycle, they interact with all other species either through predation by other piscivorous fishes or through competition for living space and food.

Work conducted by the Coeur d'Alene Tribe Fish, Water and Wildlife Program has helped determine that habitat components utilized in each of the three critical life history phases, as well as interactions with introduced species, potentially limit production of adfluvial fishes. These components include spawning habitat and juvenile rearing habitat in tributary streams, and adult rearing habitat in the lake. In order to effectively increase populations of westslope cutthroat trout, habitat restoration must take place in natal streams. However, restoration of the critical tributary habitat does not guarantee increases in adfluvial trout production because adfluvial westslope cutthroat trout reside in Coeur d'Alene Lake for two-thirds of their life cycle. Evidence suggests that production of cutthroat trout is indirectly limited by lake habitat features, but the extent of this limitation is not fully understood.

It is the intent of the Coeur d'Alene Tribe Fish, Water and Wildlife program to increase native populations of cutthroat trout to sustainable and harvestable levels. This will be achieved through restoration of critical tributary habitat and management of limiting factors in the lake. This project will examine, in as much detail as possible, the specific abiotic and biotic factors affecting the cutthroat trout population in Coeur d'Alene Lake and it tributaries. Viable options will be implemented for the effective restoration of adfluvial cutthroat trout populations which will best serve the Coeur d' Alene Tribe's goal of self-sustaining and harvestable stocks of westslope cutthroat trout.

In order to implement the steps necessary to rebuild existing trout populations to self-sustaining and harvestable levels on the Coeur d'Alene Reservation, the following goals and objectives have been identified:

- Determine the effect lake habitat, species interactions, and water quality have on cutthroat trout populations.

- Evaluate the results of tributary restoration efforts and their effects on the adfluvial cutthroat trout population dynamics.
- Provide expected population estimates of westslope cutthroat trout with the improvement of habitat. (carrying capacity of streams and actual populations).
- Determine and implement an economically feasible and scientifically valid supplementation program to provide for sustainable and harvestable populations of westslope cutthroat trout.
- Provide a short term interim fishery in catchout ponds to relieve angling pressure on weak native westslope cutthroat trout stocks.
- Construct a Trout Production Facility to provide fish for supplementation efforts and catchout trout ponds.

These objectives are designed to facilitate the decision making process regarding the proper implementation of a supplementation program for rebuilding the adfluvial cutthroat trout populations in Coeur d'Alene Lake.

5.2 Current Conditions and Limiting Factor Analysis

Water quality monitoring was completed on Coeur d'Alene Lake in order to assess its effect on cutthroat trout production. Earlier work has shown (Funk *et. al*., 1973 and 1975; Horowitz *et. al*., 1994 and Woods and Beckwith, 1995) that impacts from many different sources have caused a general decline in the water quality in Coeur d'Alene Lake. This, in turn, has had a detrimental effect on the cutthroat trout population in the lake. There is some evidence that the water quality may be improving (Woods, 1994) however, the possible legacy effects have yet to be determined.

Water Quality monitoring was completed at thirteen sites on Coeur d'Alene Lake. Multiple physical/chemical parameters were looked at between 1996-1999. Of the parameters looked at it appears that only temperature is directly influencing the distribution of cutthroat trout in the lake. Dissolved oxygen, pH, conductivity, turbidity, total suspended solids, and dissolved heavy metals appeared to be within acceptable levels for cutthroat trout survival. However, dissolved oxygen and suspended sediments though not directly impairing cutthroat suitability does affect overall water quality and impairs some use by cutthroat trout.

Low quantities of dissolved oxygen did occur at some of the sample sites however, they were not considered limiting for cutthroat trout suitability. This does not mean that it does not indirectly affect cutthroat trout suitability in the southern chain lakes area. Low dissolved oxygen values most likely are occurring from decomposition of organic matter from allochthonous sources as well as from aquatic macrophytes. Reiman (1980) and Woods (1989) noted hypolimnetic oxygen deficits in Coeur d'Alene Lake in 1979 and 1987 as well.

Increased loading of sediments from agricultural runoff does affect cutthroat trout suitability, though not directly, in areas near the mouths of streams in and around the lake. Sediment is accumulating at the mouth of Plummer creek in Chatcolet Lake at a rate of 2.4 cm/year (Breithaupt, 1990). This, in turn, increases the surface area where large masses of aquatic macrophytes can grow. These masses of aquatic can impair juvenile and adult migrations through these areas. These areas are also prime foraging areas for larger non-native piscivorous fishes.

The deposition of trace elements in the sediments of Coeur d'Alene Lake is well documented (Funk, 1970; Reiman 1980, Woods, 1989). Measured levels of dissolved metals did not appear to be directly affecting cutthroat suitability in Coeur d'Alene Lake. However, when coupled with increases in hypolimnetic oxygen deficits the potential for release of large quantities of the trace heavy metals becomes a real possibility. Currently, the principle means of controlling the levels of dissolved heavy metals in the waters of Coeur d'Alene Lake is keeping them bound up in the sediments of the lakebed. This means that managing the nutrient and sediment income in order to curtail the development of anaerobic conditions that would facilitate the release of these metals from the sediments is of paramount importance.

Nutrient and chlorophyll$_a$ levels did not appear to be significantly high when compared to values reported by Woods and Beckwith (1995) in 1991 and 1992. Analysis of the species composition of the algae by Woods and Beckwith in 1991 and 1992 showed very few, if any, species which would indicate a problem with eutrophication or a trend towards a change in trophic status in the main parts of Coeur d'Alene Lake. However, the presence of some blue-green algae in the southern lakes sample stations indicates that there is a change in trophic status towards eutrophic as you move along a southerly axis in the lake. This would most likely have a detrimental effect on the distribution of cutthroat trout in those areas. Also, large masses of aquatic macrophytes are present in the southern chain lakes area which, in all probability, are utilizing large quantities of the available nutrients and keeping chlorophyll values lower than they would normally be with the same amount of nutrients. Breithaupt (1990) completed work in Chatcolet Lake that showed the highest peaks of total phosphorous occurred shortly after peak runoff however, these were not accompanied by corresponding changes in algal biomass.

Trophic state indices calculated in 1975 (U.S. EPA, 1977) classified Coeur d'Alene Lake as mesotrophic lakewide. Data collected in 1989 (Breithaupt, 1990) classified the southern lakes area as eutrophic during the peak runoff period and mesotrophic for the other times of the year. Woods (1992) classified Coeur d'Alene Lake as oligotrophic for all parameters except secchi disk transparency, which classified the lake as mesotrophic. Our data classified the lake as oligotrophic in the north and meso-eutrophic in the south with variable conditions ever increasing along a longitudinal axis towards the southern end of the lake.

Changes in the trophic state of the lake can also have dramatic effects on the succession of fish species within a lake. Hayward and Margraf (1987) showed rapid successional changes in the species structure of fish as a result of trophic status changes in Lake Erie. Leach *et al.* (1977) showed successional changes in response to trophic status changes but it was much slower. As a lake becomes more oligotrophic after clean up or restoration it can be expected that some change in the fish species abundance is going to occur. Some species will be able to take advantage of it and others will not. It is not surprising that salmonid populations have declined as a result of the eutrophication of Coeur d'Alene Lake from 1950-1970’s. However, evidence suggests that in some portions of the lake this process may be reversing itself and slowly going towards oligotrophy again. This may mean that conditions which favored salmonid populations historically may return however, the successional changes may not mirror the response to eutrophication. As far as cutthroat trout are concerned, once they are replaced by another salmonid species (i.e. kokanee salmon) it is unlikely that space will ever be regained under natural conditions (Moyle and Vondracek, 1985).

Based on the water quality HSI’s calculated for cutthroat trout, the upper 10 meters of the water column generally is not suitable habitat. At only one location was the HSI value higher than 0.0. This does not mean that cutthroat trout will not be found there but they will have trouble sustaining themselves over a long period of time. Furthermore, the euphotic zone rarely drops below 10 meters so any foraging runs into that zone will take them into unsuitable habitat, which results in added stress. Thus, all areas represented by sample stations less than ten meters in depth would be considered unsuitable cutthroat trout habitat with deeper stations showing limited distribution during certain times of the year.

It does appear that improvements in the water quality of Coeur d'Alene Lake are occurring however, water quality is still having a detrimental effect on cutthroat trout suitability. In addition to the direct affects of temperature on cutthroat trout suitability, indirect effects related to low dissolved oxygen concentrations, total suspended solids, and large masses of aquatic macrophytes effectively limit the cutthroat trout population in the areas where these conditions exist. Specifically, these areas include the two shallow stations, the three southern chain lake stations, and the three interior bay stations; the sample locations most affected by construction of Post falls Dam.

There is no doubt that inter-specific species competition occurs between cutthroat trout and other fish species, especially the introduced ones (Griffith 1974,1988; Marnell 1986, 1987, 1988; and others). It is unclear, in Coeur d'Alene Lake, which mechanism is controlling the population competitive exclusion and/or replacement due to rapid changes in the environmental conditions within the lake. The fact that the adfluvial population has not been extirpated from the lake shows that these fish have some resiliency to the detrimental effects from interactions with the introduced species. Petroskey and Bjornn (1985) demonstrated that cutthroat in the St. Joe River system show little detrimental effects from the introduction of hatchery reared rainbow trout. Griffith (1988) postulates that this resiliency may be more attributed to the fact the cutthroat are not existing in habitat that is optimal for them but existing in habitat that is sub-optimal for the other species.

It is thought that juvenile cutthroat trout spend some time in the littoral zone just after they enter the lake from the tributaries where they would be subject to predation by these larger piscivorous fishes. It can be expected that some mortality will occur during this life stage. Insufficient data has been collected do determine exactly what effect this life stage mortality has on the overall population dynamics of the cutthroat trout in Coeur d'Alene Lake.

Of the introduced species the following have been shown to have the ability to actively feed on other fish species including adult and juvenile cutthroat trout: northern pike, largemouth bass, smallmouth bass, chinook salmon, and channel catfish. Historically, bull trout and northern squawfish were the only predators of cutthroat trout in the lake. Electrofishing data shows that these predators are associated primarily with the shoreline littoral zone. The relative abundance data shows that five species of piscivorous fishes (four introduced) have relative abundances higher than cutthroat trout. This would indicate that cutthroat are probably being competitively excluded from this littoral zone habitat by these other fishes.

Historically, cutthroat trout in Coeur d'Alene Lake probably utilized the littoral zone of the lake until they were large enough to move offshore and feed, most likely, on mid water prey and fish when available. Nilsson and Northcote (1981) noted that cutthroat trout in allopatry with other salmonids were found throughout the lake and in sympatry, they were located primarily in the littoral zone. It has been shown that introduction of kokanee salmon will also have detrimental effects on the cutthroat trout population (Gerstung, 1988; Marnell, 1988). Marnell (1988) determined that declines in westslope cutthroat trout populations in lakes in Glacier National Park where kokanee were introduced were caused by competition for planktivorous food. Thus, the introduction of non-native species into Coeur d'Alene Lake, at the minimum, altered the normal behavioral pattern of the cutthroat trout in both the littoral and limnetic zones of Coeur d'Alene Lake.

Based on the relative abundance information from 1994-1997 it appears that cutthroat trout are more successful in the limnetic zone than the littoral zone. In the limnetic zones with depths greater than 10 meters cutthroat trout were the third most abundant fish species caught. In the littoral zones of these same areas cutthroat trout were one of the least abundant species caught. Introduced species made up over 68% of the catch in relative abundance studies from 1994-1997 while cutthroat trout comprised less than 1% of the catch. In the littoral zones problems associated with temperature and inter-specific interactions are maximized. In the limnetic zone there is some relief from the effects of temperature however, problems associated with introduced species still exist. In relative abundance studies completed in the limnetic zones greater than ten meters deep from 1994-1997 introduced species (kokanee salmon) made up only

32% of the catch. There appears to be some association with the locations where cutthroat trout are caught in both the littoral and limnetic zones. It appears that in areas where fish are found in the limnetic zones they are also found in the littoral zones located nearby. This could mean that these fish are avoiding high temperatures in the upper waters by making foraging runs into the littoral zones during times when the water temperatures cool slightly at night. This could also be a predator avoidance mechanism as well.

A complete discussion of current conditions in the target tributaries is found in section 2 of this report and in Peters et. al. (1999) and is briefly summarized here. Range wide causes of decline include competition with and predation by non-native species, genetic introgression, overfishing, habitat loss and fragmentation, and habitat degradation (Liknes 1984; Liknes and Graham 1988; Rieman and Apperson 1989; McIntyre and Rieman 1995). In Idaho, habitat loss was identified as the primary cause of decline in streams supporting depressed populations (Rieman and Apperson 1989). Peters et. al. (1999) determined that due to the persistence of adverse conditions in natal streams and Coeur d'Alene Lake, cutthroat trout populations are thought to be at least moderately damaged (i.e. average spawning escapements fall between the minimum viable population and the number of adults needed to produce 50% of the carrying capacity of the stream environment) for the following reasons:

- Stochastic events that result in increased mortality of embryo, fry, and juvenile lifestages (e.g. peak and extreme low flow events) have been exacerbated by land use practices during the last 60 years;
- Competition for limited space and food during base flow conditions cause displacement of juveniles into water quality limited stream reaches;
- Competitive interactions with introduced salmonids may result in replacement of native trout in Alder Creek and Benewah Creek;
- Water temperatures in the upper ten meters of the water column in Coeur d'Alene Lake exceed the optimum as described in the HSI for cutthroat trout;
- Sediment loading from tributaries in combination with large quantities of aquatic macrophyte growth and low dissolved oxygen concentrations in the hypolimnion promote conditions more favorable for introduced fish species in Coeur d'Alene Lake; and
- Competitive interactions with introduced species for food, living space, and through predation limit cutthroat trout in both the littoral and limnetic zones of Coeur d'Alene Lake.

Restoration efforts rectifying many of the habitat concerns have been and will continue to be conducted in each of the target watersheds. However, given the various physical and environmental constraints limiting production it is doubtful that habitat restoration, in itself, will result in substantial increases in the production of cutthroat trout in the near future. An extensive discussion on carrying capacity and production potentials of the target watersheds is found in the Coeur d'Alene Tribe Trout Production Facility Master Plan (1999) specific to the target watersheds that can be used to estimate the potential production capacity for cutthroat trout. These results are also summarized in subsequent sections. Based on available data it can be assumed that production is relatively low when compared to other North Idaho cutthroat trout bearing streams. Although habitat restoration work and better resource management will result in improved survival rates for cutthroat trout it is believed that any significant increase in the total run size will require hatchery supplementation.

5.3 Conceptual Approach to Supplementation in Waters of the Coeur d'Alene Reservation

For the purposes of this document, supplementation is defined as the stocking of fish into native habitat to increase the abundance of naturally reproducing fish populations. Maintaining the long-term genetic fitness of the target population, while keeping the ecological and genetic impacts on non-target populations within acceptable limits, is inherent in this working definition.

Supplementation has been a common strategy for increasing natural fish production in the Columbia River Basin. However, there is not yet a detailed understanding of which techniques work best under which circumstances (Cuenco, et. al. 1993). On the Coeur d'Alene Indian Reservation, supplementation activities will involve stocking fish into habitats that contain depressed but existing natural fish populations. Unlike many traditional hatchery programs, the objective of supplementation here is to increase the abundance of naturally reproducing fish populations, and therefore is oriented toward maintaining the natural biological characteristics of the population and reliance on the rearing capabilities of the natural habitat. Supplementation measures will not obviate the need to concurrently pursue other necessary actions such as habitat protection and improvement, and harvest management to rebuild stocks.

The objective of supplementation will be to boost the population density above a certain minimum viable population size as quickly as possible. These values are currently under investigation and will be developed with the initial management strategy. The concept is to employ a supplementation program to a level that minimizes the risk of extirpation. The primary role of supplementation in this case is to increase the survival rate of the population during its early life history (egg through smolt) relative to its survival rate under natural conditions. It is anticipated that this effort will result in increased adult returns to seed sparsely populated habitats and provide for limited harvest opportunities.

For depressed stocks that exist in tributaries of Coeur d'Alene Lake, the question of how many or what proportion of the natural stock to intercept for broodstock can only be resolved by careful evaluation of the impact of initially taking a small fraction of the depressed population for broodstock. An important consideration will be to ensure that capture of broodstock does not reduce the number of naturally spawning adults required to maintain the minimum viable population.

5.4 Application of the Conceptual Approach

Implementation of the supplementation program will be conducted in three phases. Phase I will be to restore natural production by implementing active and passive stream restoration projects in the target tributaries directed at increasing the natural capability of the stream to support westslope cutthroat trout. Phase II will be to construct an artificial production facility and gather broodstock from each of the four target tributaries and raise and release the progeny into their ancestral drainages. Phase III will be to monitor adult returns and manage the ratio of native and hatchery reared returning adults in order to maintain the genetic fitness of the population spawning in the wild.

5.4.1 Genetic considerations

Resource managers have long been aware that genetic variation is an important aspect of species viability. In many instances, however, fish managers have selected for certain traits to alter or "improve" the quality of their stocks with little understanding of genetic principles and potential ramifications (Erdahl, 1993). For example, Kincaid (1976) found that loss of genetic variation in rainbow trout caused a reduction in survival, increases in deformities, and a reduction in weight gain after one year. Thus, when dealing with limited numbers of fish from a sensitive population, great care must be exercised in order to preserve the unique genetic quality of the population while promoting survivability in both the hatchery and wild environments.

Loss of genetic variation results from genetic drift, mating of related individuals, and intentional selection for particular traits (e.g. size, color). Loss of genetic variation in a hatchery system cannot be eliminated; however, the loss can be minimized. Methods to minimize the loss of genetic variation include 1) collect baseline data (e.g. electrophoretic and/or DNA analysis); and 2) plan management practices that include procedures which maintain variation (e.g., infuse wild genes into the gene pool). Erdahl (1993) recommends a minimum broodstock population of 200 fish, with an infusion of 10 percent wild genes each season for proper maintenance of the genetic viability of the population. Finally, the following practices should be kept in mind when mating fish: spawn one female with one male, avoid inbreeding, have an equal contribution of offspring from each mating, crossbreed in order to infuse new genes into the gene pool, and avoid selection.

5.4.2 Native Fish Interaction

One of the main goals of our restoration and supplementation program will be to maintain the genetic integrity of the wild populations as well as, increase the numbers of fish reproducing in the natural environment. The purpose of the supplementation program is to restore the naturally reproducing populations to historic levels commensurate with the carrying capacity of the natural habitat. Thus, the adverse effects of predation, competition for food and living space, and disease should be no more than what was experienced by the population when at historic abundance levels. The supplementation program proposed seeks to minimize or eliminate any differences between the stocked and wild fishes so that they are a single population. Hatchery releases will be proportional to natural production so that the carrying capacity of the stream is not surpassed.

5.4.3 Carrying Capacity of Target Tributaries

Methods
See Coeur d'Alene Tribe Trout Production Facility Master Plan (1999) for complete carrying capacity analysis. The following is a summary of that discussion.

The carrying capacity of the target tributaries was predicted by inputting measured habitat and water quality parameters into a Habitat Quality Index (HQI) model which was developed to predict trout standing crop in Wyoming streams (Binns and Eiserman 1979). The HQI Model II was originally used to predict trout biomass in Wyoming streams using eleven attributes: late-summer stream flow, annual stream flow variation, maximum summer water temperature, nitrate nitrogen, fish food abundance, fish food diversity, instream cover, eroding streambanks, submerged aquatic vegetation, water velocity, and stream width. The model explained 96% of the variation in trout biomass for the 36 streams from which it was developed, and 87% of the variation for 16 Wyoming streams examined in a follow-up study by Conder and Annear (1987).

Griffith (1993) reported that attempts to apply the HQI to populations of salmonids in streams outside of Wyoming have generally not been successful, citing that trout populations in different areas respond to different sets of factors. Binns and Eiserman (1979) acknowledged such weaknesses in the original model, indicating that anomalies in trout population densities caused by extremes in climatic conditions or by anthropogenic influence could cause variability in HQI predictions. They suggested that specific understanding of the life history requirements of target species would justify modifications of model variables to provide more accurate evaluations of local habitat conditions.

We felt that modifications of the attribute for maximum summer water temperature were needed to reflect the specific tolerances of westslope cutthroat trout. The original model was applied to streams that supported multiple salmonid species (including brook, brown, rainbow, and cutthroat trout) and used temperature ranges that were, in some cases, higher than the upper incipient lethal temperature reported for cutthroat trout (Behnke 1979; Behnke and Zarn 1976; Bell 1973). We modified the temperature rating characteristics of the model by using values that corresponded to 20-100% suitability on the suitability index graph published by Hickman and Raleigh (1982). In addition, we changed the lower rating characteristic for the late summer stream flow attribute to reflect the fact that tributaries on the Reservation support juvenile trout to a much greater extent than resident adults. Therefore, in our model late summer stream flows ≥8% of average annual stream flow provide at least sporadic but limited support for juvenile rearing. Data published by Hickman and Raleigh (1982) indicating 100% suitability for juvenile cutthroat residing in small streams when the average thalweg depth reaches 30 cm, seem to support this assumption.

Juvenile Rearing

When HQI scores ($\hat{Y}$) were plotted against the three-year mean of measured trout standing crop (Y), the scatter of data points was best fitted by the linear equation $Y = 1.779 + 0.911(\hat{Y})$. The model explained 83% of the variation in trout standing crop for 8 tributaries that were tested, and a high correlation coefficient ($R = 0.915$) suggested a strong relationship between HQI score and trout standing crop. For two tributaries (Evans Creek and SE Benewah Creek), there was considerable deviation between measured and predicted values. In Evans Creek, a history of human intervention probably explains the difference between these values. Evans Creek served as a source of brood stock for state sponsored stocking programs, and adfluvial adults were captured and removed throughout the 1970's and early 1980's (personal communication, IDFG). We believe this resulted in complete failure of multiple year classes, and compensatory survival (a result of decreased competition and increased growth in response to favorable conditions) has not yet resulted in reseeding of available habitats. Reasons for the discrepancy between measured and predicted values in SE Benewah are unknown, but are thought to be reflective of underseeded spawning habitat. Given the results of model predictions and in consideration of mitigating factors, we believe the HQI Model II is a reasonable predictor of cutthroat trout standing crop for Reservation streams and can be used as an indicator of juvenile carrying capacity.

The tested model was used predict changes in carrying capacity given several projections of expected improvements in habitat quality resulting from ongoing restoration. The projections correspond to 25%, 50%, 75% and 100% improvement targets as adopted into the 1995 Columbia River Basin Fish and Wildlife Program (10.8B.20). Realistic dates for these respective levels of habitat improvement have been designated as 2007, 2012, 2016 and beyond. The habitat attributes that are thought to be most responsive to restoration techniques during these timeframes, and which have been manipulated during iterations of model predictions, include late summer stream flow, eroding streambanks, instream cover, fish food abundance and maximum summer water temperature. Late summer stream flow was only manipulated in the final iteration (beyond category) of the model.

The 2007 prediction of carrying capacity constitutes a 2.4% increase in the total number of juveniles compared with current values (Table 5.1). This prediction was arrived at by improving the instream cover and eroding streambank attributes by a 5% increment in all tributaries that did not receive the highest attribute rating. All other attributes were left unchanged. The 2012 prediction constitutes a 34.7% increase in the total number of juveniles compared with 1998 values (Table 5.1). This prediction was arrived at by improving the instream cover and eroding streambank attributes by an additional 5% increment in all tributaries that did not receive the highest attribute rating. In addition, maximum summer water temperature was decreased by 1°C in all tributaries that exceeded 17°C. The 2016 prediction constitutes a 117.1% increase in the total number of juveniles compared with 1998 values (Table 5.1). This prediction was arrived at by improving the instream cover and eroding streambank attributes by an additional 5% increment in all tributaries that did not receive the highest attribute rating. In addition, maximum summer water temperature was decreased by 1°C in all tributaries that exceeded 16.8°C.

Table 5.1

Carrying capacity predictions for juvenile cutthroat trout in tributaries of the Coeur d'Alene Reservation.

	Standing Crop (kg/hectare)					Number of Juveniles				
Tributary	**1998**	**2007**	**2012**	**2016**	**Beyond**	**1998**	**2007**	**2012**	**2016**	**Beyond**
Lake Creek (Lower)	8	9	24	27	88	1036	1165	3108	3496	11396
Lake Creek (Upper)	49	49	68	108	150	7322	7322	10161	16138	22414
Evans Creek	122	122	158	250	250	18129	18129	23478	37149	37149
N.F. Alder Creek	30	33	45	83	184	1132	1245	1698	3333	7390
Alder Creek	25	28	37	37	95	4211	4716	6232	9510	24418
Benewah Creek (mainstem)	14	14	14	39	55	4577	4577	4577	13313	18775
S.E. Fork Benewah	95	100	130	130	180	2401	2527	3285	3655	5060
West Fork Benewah	76	80	80	80	111	1200	1263	1263	964	1337
Whitetail Creek	19	19	25	43	76	461	461	607	863	1526
Windfall Creek	20	22	30	51	90	828	910	1241	1229	2169
Totals	458	476	611	848	1279	41295	42316	55650	89650	131633

The prediction for the “beyond” category is a best professional judgement that approximates the desired future condition for Reservation tributaries (Table 5.1). Desired future condition is defined as being equivalent to the potential natural community. In other words, biological productivity and diversity at the landscape level is equivalent to the site potential. This concept can be described as a situation where natural aquatic ecosystem functions are similar to those in which the landscape developed and its component parts evolved, but with the recognition that a number of human-caused factors will preclude a complete return to the historical condition. However, under this scenario ecological processes (succession, natural disturbances, competition, evolution, etc.) and hydrological processes (sediment transport and deposition, flood plain storage and subsurface recharge, nutrient cycling, etc.) function in such a manner as to ensure a sustainable intact ecosystem. This prediction constitutes a 218.7% increase in the number of juveniles compared with 1998 values (Table 5.1).

Adult Returns

Biological objectives for wild adfluvial cutthroat trout in tributaries of the Coeur d'Alene Reservation include rebuilding adult populations to 75-100 percent of the optimum level. This will be accomplished by achieving interim biological objectives (25 percent and 50 percent of optimum level) by the dates noted in Table 5.2. The target level (percent) is defined as percent improvement over current conditions based on escapement target estimates. Escapement target is defined as the number of adult fish needed to fully seed available spawning habitat. Harvest target is calculated as an exploitation rate of 35 percent.

At this time, a juvenile to adult survival ratio has not been calculated. As such, juvenile carrying capacities cannot be translated into adult return estimates. It is anticipated that ratios of hatchery returns to releases will give us some idea of this survival rate thus, any future management decisions can or will be based on a complete analysis of this information.

Table 5.2 Escapement and harvest goals for target tributaries on the Coeur d'Alene Indian Reservation.

Tributary	Target Level[a] (percent)	Escapement[b] Target	Harvest Target[c]	Biological[d] Objective	Year
Alder Creek	25	1,708	920	2,628	2007
	50	3,416	1,840	5,256	2012
	75	5,123	2,759	7,882	2016
	100	6,831	3,679	10,510	Beyond
Benewah Creek	25	2,179	1,174	3,353	2007
	50	4,357	2,347	6,704	2012
	75	6,534	3,519	10,053	2016
	100	8,713	4,692	13,405	Beyond
Evans Creek	25	984	530	1,514	2007
	50	1,968	1,060	3,028	2012
	75	2,951	1,589	4,540	2016
	100	3,935	2,119	6,054	Beyond
Lake Creek	25	2,002	1,078	3,080	2007
	50	4,004	2,156	6,160	2012
	75	6,006	3,234	9,240	2016
	100	8,008	4,312	12,320	Beyond

[a] Target level (percent) is defined as percent improvement over current conditions based on escapement target estimates.

[b] Escapement target is defined as the number of adult fish needed to fully seed available spawning habitat, given the following assumptions:

- Spawning is primarily restricted to 2nd order tributaries (CDA Tribe population data, 1994-1998);
- Usable spawning habitat comprises 4.1% of the total stream area in 2nd order tributaries, when averaged across the four target watersheds (CDA Tribe habitat assessment data, 1998);
- Potential spawning gravel was defined according to Magee et al. (1996) as patches of substrate at least 0.25 m^2 in area with particles 2-35 mm in diameter;
- Average redd size is $0.15 m^2$ (Magee et al. 1996).
- 1:1.6 male to female spawner ratio (IDFG 1998);
- 3 redds for every 2 spawning females (Scott and Crossman 1973);

[c] Harvest target is calculated as an exploitation rate of 35 percent.

[d] Biological objective is the sum of escapement and harvest targets.

The total number of fish needed to fully seed available spawning habitat was calculated using the following equations:

$$\boxed{\text{\# of Redds}} = \text{Total area of 2nd order streams} * 0.041 \div \text{Ave. redd size } (0.15\ m^2)$$

$$\boxed{\text{\# of Redds}} \div \boxed{\text{\# of Females}} \div \boxed{\text{\# of Males}}$$

$$\boxed{\text{\# of Females}} + \boxed{\text{\# of Males}} = \text{Estimated total number of adult fish to fully seed available spawning area.}$$

5.5 Coeur d'Alene Tribe Trout Production Facility- NPPC 3-Step Process, Production Profiles, Production Goals, Broodstock Selection, Stocking Strategies, Genetic Concerns

The hatchery will be expected to produce 40,000 catchable sized rainbow trout (12.5 inches long and ¾-1 pound apiece) and up to 500,000 fry and up to 100,000 fingerling cutthroat trout for supplementation efforts in the target tributaries (Table 5.3). The hatchery will also support up to 2000 adult cutthroat trout for use as captive broodstock.

Table 5.3 Maximum Production Capacity of Coeur d'Alene Trout Production Facility

Number of Fish	Ave. Size/ Ave Weight	Species/Life Stage	Pounds Produced Annually
2,000	20 inch/2.8 lbs.	CTT/ Broodstock	5,600 lbs.
500,000	1.5 inch/1.2 lbs. per 1000	CTT/ Fry	600 lbs.
100,000	4 inch/22.6 lbs. per 1000	CTT/ Fingerling	2,260 lbs.
40,000	12.5 inch/780 lbs. per 1000	Rainbow Trout/ Adult	31,200 lbs.
Total 642,000			39,660 lbs.

Broodstock will be collected from each of the four target tributaries. All broodstock will be collected from the same stock in each target tributary. These fish will be collected as fry and held until adults in order to minimize affects on the natural populations. Each year 100-200 fry will be collected from the same sites in the target watersheds. These fish will be individually marked and placed into separate ponds. As these fish mature they will be used as broodstock.

The hatchery will be designed for artificial spawning of coldwater salmonids. Standardized methods for mating described by Piper et. al. (1982) will be used to protect and preserve localized adapted traits. The artificial method of spawning will consist of manually stripping the sex products from the fish, mixing them in a container, and placing the fertilized eggs into an incubator. The spawning method will be designed to reduce handling of fish. The eggs will be hand stripped from a female by gently grasping the fish near the head with the right hand and the body with the left hand. The fish is then held with the belly downward over a pan where the eggs are forced out. Milt is then added from the male expressed in a similar manner. Water is added to wash the eggs prior to incubation.

Cutthroat trout will be initially stocked as juveniles. They will be placed in an acclimation pond adjacent to the individual target tributary. The pond will be fed with water from the stream. Fish when ready will be released and allowed to leave the pond on their own volition. If adult returns are poor from this stocking strategy then other types of stocking will be experimented with (i.e. fry plant). Releases will be timed to minimize the effects of competition with the wild population.

Certified eyed rainbow trout eggs will be purchased and raised in the hatchery. When ready the fish will be outplanted into the catchout ponds. As fish are removed from the pond more will be added up to 10,000 per pond annually.

Section 6:

Monitoring and Evaluation

6.1 Introduction

The purpose of this section is to assist the project manager in developing a monitoring and evaluation (M&E) plan for reservation streams and Coeur d'Alene Lake. The focus of this discussion is the preferred approach and the types of monitoring to be used. The approach described is applicable to monitoring and evaluation of individual projects, as well as overall program effectiveness.

6.1.1 Objectives and Approach

Coeur d'Alene Tribe Fish, Water and Wildlife personnel realize that effective monitoring is critical to a successful adaptive management program. Effective monitoring determines whether the action completed achieved the stated objectives. Since monitoring activities may overlap, there is a need to develop M&E activities into an integrated plan. Furthermore, this monitoring plan should be revised and amended as part of the adaptive monitoring process that is specifically recommended in section 2.2H of the 1994 NPPC F&W program.

The ultimate purpose of the M&E plan is to evaluate the responses of native cutthroat trout populations to different riparian, instream and lacustrine management practices. The fundamental objectives of the monitoring and evaluation program are to:

1) Document the habitat changes associated with different habitat enhancement practices;
2) Document the responses of cutthroat trout population to changes in the aquatic/riparian interface and to changes in lacustrine conditions;
3) Account for enhancement costs; and
4) Acquire new knowledge about the physical and/or biological effects and interactions of stream and lacustrine enhancement measures.

Specific steps must be followed if meaningful results are to be obtained from a monitoring study (Figure 6.1). The first three steps, documentation of baseline condition, development of management objectives, and designing an implementation strategy, have been discussed in previous sections. Key considerations for a properly designed monitoring program include the following:

- Measurement of management responses is made possible through hypothesis testing to determine if objectives are met. This depends on having a clearly stated hypothesis that can be tracked with a management objective, and the variable must be responsive to the management that will be applied.
- Control areas that will not receive management treatments must be included in the study. Control and treatment sites must have the same characteristics and the same potential for response to management. This precaution is necessary if changes attributable to management are to be detected.
- Resources must be available for monitoring through an adequate period to permit management responses to occur.

- Management must be consistent with the original plan throughout the study. Problems occur when changes are made in management, preventing accurate interpretation of data. An example is the trespass of livestock and subsequent overgrazing and habitat changes in control areas.

Statistical tests to analyze information are designated when the monitoring program is designed and assumptions for proper use of the tests are met. Special considerations for step 5 (Figure 6.1) include: 1) maintenance of accuracy and precision in collecting data, 2) the expending of equal levels of effort and adherence to the same technical standards in control and treatment sites to prevent bias from influencing results, and 3) the recording and processing of data suitable for retrieval and use in statistical analysis. Based on results of hypothesis testing, it is possible to conclude whether objectives are met. If they are not met, there are two options: modify objectives and repeat the process in Figure 6.1 until they are eventually met, or modify management and repeat the process until success is achieved. One concept that must be emphasized is that monitoring should not result in a strict "pass" or "fail" conclusion. There cannot be a failure if negative results contribute to avoidance of management practices that do not work. Therefore, it is equally important to document unsuitable practices.

In the face of scientific uncertainty, monitoring and evaluation will provide insight into the actual result of an action, as well as, explain the outcome in achieving predicted results. The Coeur d'Alene Tribal Fish, Water and Wildlife project biologists and managers will complete and initiate an integrated multi-level M&E program. This program will ensure that strategies are implemented as intended, experimental studies provide reliable results, and that risks associated with uncertainties are contained. It also ensures efficiency, prevents duplication of efforts, and tracks progress towards meeting objectives. The following elements may be included in each type of monitoring plan:

- Quality control: monitoring the performance of the program and their operators. Monitoring procedures would be included in the standard operating procedures for all activities associated with the program.
- Product specifications: monitoring the program to determine whether projects meet goals with respect to estimated cost, predicted outcome, and overall efficacy of each individual project.
- Innovative methods: research activities including implementation of innovative techniques and principles in assessing a habitat restoration project as well as revising and adapting management practices.
- Monitoring of stock status: measurements of run size and escapement to determine whether harvest objectives are being met while aiding in natural production as well as providing information essential to track long-term performance and fitness of the fish population.

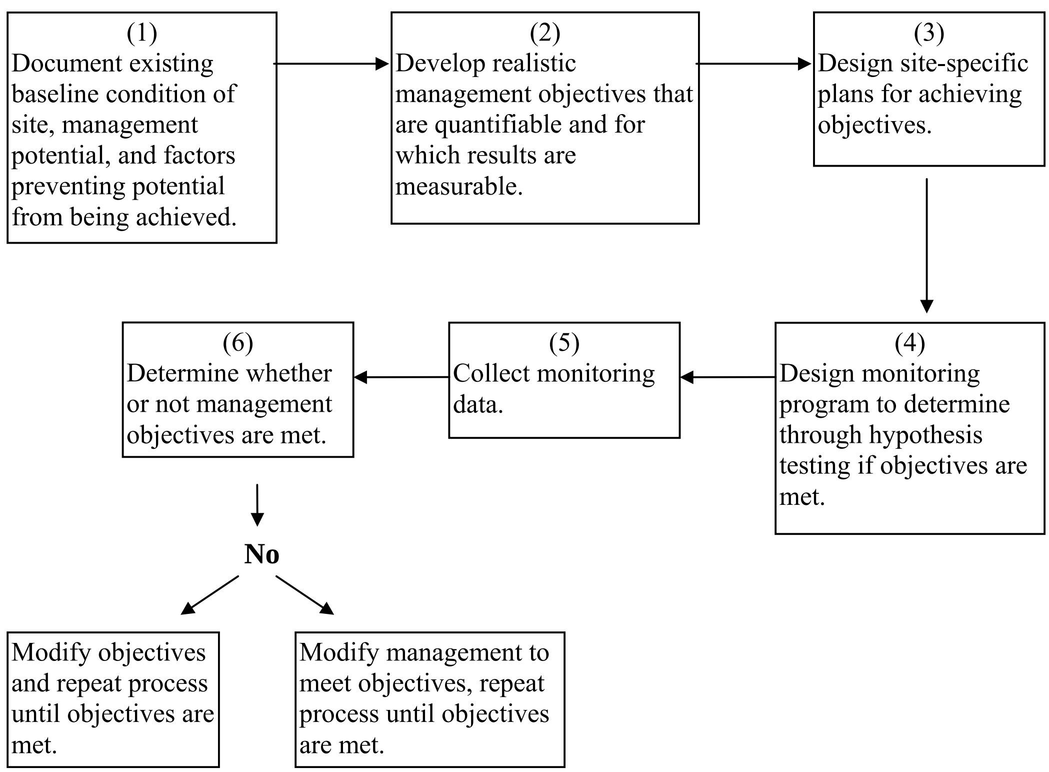


Figure 6.1 Steps for a monitoring program (modified from Armour and others, 1983).

6.1.2 Types of Monitoring

The term monitor suggests a series of observations over time. This repetition of measurements for the purpose of detecting change distinguishes monitoring from inventory and assessment. For the purposes of this document, the following types of monitoring are defined:

- *Baseline monitoring*. Baseline monitoring is used to characterize existing habitat or population conditions, and to establish a database for planning or future comparisons. This type of monitoring is also referred to as pre-implementation evaluation, and is described more fully in Section 2.4.3. The need for baseline monitoring is to be determined prior to implementation of individual projects and is based on data availability.

- *Implementation monitoring*. This type of monitoring assesses whether activities were carried out as planned. The assessment is an administrative review and does not involve any detailed field measurements. This assessment should be completed for each implementation activity and the results summarized in annual reports. An annual review of implementation assessments can then be undertaken to facilitate an adaptive approach to managing implementation activities. Considerations of the assessment should include the following:

    1) Compare projected and final implementation costs;
    2) Determine if implementation efforts met the stipulations and special conditions of the regulatory permits;
    3) Evaluate whether completed enhancement measures meet all technical specifications described during the planning stages;
    4) Project whether completed enhancements will still be sufficient to meet project specific goals and objectives;
    5) Solicit feedback from the landowner, cooperating agencies, and other interested parties regarding efficiency of implementation efforts and expected effectiveness of rehabilitation measures.

- *Effectiveness monitoring*. Effectiveness monitoring is used to evaluate whether the specified activities had the desired effect. Effectiveness monitoring will be used in evaluating individual restoration projects. Evaluating individual projects may require detailed and specialized measurements best made at the site, or immediately adjacent to the management practice. Effectiveness monitoring may include: population assessments that describe habitat utilization; physical habitat assessments that describe changes to channel morphology, hydrology, and riparian function; or water quality assessments that document fluctuation in temperature or dissolved oxygen. Additionally, effectiveness monitoring is to be used when assessing the performance of artificial habitat structures.

- *Project monitoring*. This type of monitoring assesses the impact of several enhancement projects on the function of ecological processes within each target drainage and Coeur d'Alene Lake and the overall response of cutthroat trout populations. Often this assessment will be done by comparing data taken upstream and downstream of a series of interrelated enhancement projects, or the comparison may be on a before and after basis. The scope of this type of assessment necessitates a long-term commitment to monitoring in order to compensate for the inter-annual variability of natural systems. Monitoring undertaken at this level will include annual assessments of fish population abundance and distribution, as well as, drainage specific water quality analyses.

It should be emphasized that the four types of monitoring described above are not mutually exclusive. Often the distinction between them is determined more by the purpose of monitoring than by the type and intensity of measurements. Table 6.1 provides a broad classification of monitoring types according to the parameters being measured, the frequency of monitoring, the duration of monitoring, and the intensity of data analysis.

Table 6.1. General characteristics of monitoring types (MacDonald, 1991).

Type of monitoring	Number of type of parameters	Frequency of measurements	Duration of monitoring	Intensity of analysis
Baseline	Variable	Low	Short to Medium	Low to Moderate
Implementation	None	Variable	Duration of Project	Low
Effectiveness	Near Activity	Medium to High	Short to Medium	Medium
Project	Variable	Medium to High	>Project Duration	Medium

6.2 Project Specific Monitoring and Evaluation Plans

6.2.1 Monitoring and Evaluation of Tributary Restoration

Restoration projects are initially proposed to correct a perceived or documented water quality or habitat related problem. These problems must be defined in terms of measurable stream variables or stream attributes. Monitoring needs to detect changes due to management separate from changes attributed to natural variability. The object of monitoring planning and design is to select those key variables at representative sites that are expected to respond to management. Selection of key variables involves a sorting process, based on the watershed project objectives and considering the realistic constraints of monitoring.

The development of a monitoring plan includes compiling existing information and gathering data from a field reconnaissance to focus the scope of monitoring. These questions should be considered throughout the planning process.

- What are the issues and concerns that started the project?
- What are the potential limiting factors for the target species?
- Are these limiting factors influenced by land management activities?
- What is currently known about the existing stream condition?
- What additional information is needed to make an assessment of existing stream condition and cause and effect?
- Of the potential stream/riparian variables, which key variables are expected to respond to project management?
- What are the monitoring project constraints in terms of budget, personnel availability, expertise, site conditions, and other factors?

This section describes monitoring and evaluation methods specific to stream restoration projects that are both easy to use and cost effective (Table 6.2). This is achieved by using methods that reduce sample frequency, minimize the need for specialized equipment, and reduce costly laboratory analyses. The methods described focus primarily on attributes of the stream channel, stream bank, and streamside vegetation of wadable streams. Monitoring parameters are sampled generally during low flow conditions in the summer when streams can be waded. The methods require relatively inexpensive equipment compared to standard water chemistry analysis techniques. Implementation of these methods requires building and training an interdisciplinary monitoring team.

Table 6.2. Restoration monitoring: minimum sample frequency, estimated collection time, equipment needed, lab costs, and expertise.

Attribute	Parameter/ Protocol	Frequency (time/year)	Collection Time (hours/site)	Comments	Equipment	Lab Costs* ($/sample)	Expertise**
I. I. Water Column a. Temperature	Min/Max Thermometers	6-10 during summer	<1	Good for initial evaluation.	Min/Max Thermometers	None	F: Technician A: Fisheries/ Hydrology
	Recording Thermograph	Continuous during summer	1-2	Provides a complete data record.	Recording Thermograph	None	F: Technician A: Fisheries/ Hydrology
b. Shade	Canopy Density/ Densiometer Platts et al. (1987)	1	2-4	Applies to streams with woody vegetation	Densiometer	None	F: Technician A: Fisheries/ Hydrology
	Solar Heat Input/ Solar Pathfinder Platts et al. (1987)	1	4-8	Limited to small and medium streams	Solar Pathfinder	None	F: Technician A: Fisheries/ Hydrology
c. Nutrients	T. Phosphorus, T Nitrates Standard Methods APHA (1990)	Twice/Month or Flow dependent	<1	Flow dependent- requires frequent sampling	Grab samples or automatic samplers	$30-$50	F: Technician A: Fisheries/ Water Quality
d. Fecal Bacteria	Fecal Coliform, Fecal Strep. Standard Methods APHA (1990)	Twice/Month or dependent on objectives	<1	Flow dependent when associated with bottom sediments	Grab samples	$10-$20	F: Technician A: Water Quality
II. Stream Channel/ Streambank a. Channel Morphology	Channel Cross Section Rod and Level or Sag Tape Methods Platts et al. (1987)	1	4-8	Bankfull level may be difficult to locate.	Rod and level	None	F: Technician A: Hydrology
	Width/Depth ratio Platts (1983) – 3 point method	1	2-4	Water width and depth vary within season	Tape and rod	None	F: Technician A: Technician
b. Streambank Stability	Streambank Soil Alteration and Stability Rating Platts et. al. (1987)	1	1-2	Soil alteration measures false, broken, or eroding banks. Bank stability rates bank protective cover.	Tape	None	F: Technician A: Fisheries/ Hydrology

Attribute	Parameter/ Protocol	Frequency (time/year)	Collection Time (hours/site)	Comments	Equipment	Lab Costs* ($/sample)	Expertise**
	Streambank Cover and Stability Rating (bank length) USDA Forest Service (1992)	1	1-2	Uses simplified rating of cover and stability.	Tape or rod	None	F: Technician A: Hydrology/ Fisheries
c. Substrate Sedimentation	Particle Size Distribution- Percent Fines Pebble Count Wolman (1954)	1	1	Estimates percent of substreate surface area covered by fines.	Rulers	None	F: Technician A: Hydrology/ Fisheries
	Percent Surface Fines Grid Method	1	2-4	Requires numerous plots to assess spatial variability.	Metal or plexiglass grid	None	F: Technician A: Hydrology/ Fisheries
	Cobble Embeddedness Skille and King (1989)	1	4-8	Use is limited by high variability.	Hoop and scale	None	F: Technician A: Hydrology/ Fisheries
d. Pool Quality	Pool Quality Rating Platts et al. (1983, 1987)	1	<1	Rates pool quality according to depth and cover.	Measuring rod	None	F: Fisheries A: Fisheries
	Pool Quality Rating USDA Forest Service (1992)	1	<1	Rates pool quality on depth, substrate and cover.	Measuring rod	None	F: Fisheries A: Fisheries
e. Vegetative Overhang	Vegetative Overhang (at transect) Platts et al. (1987)	1	<1	Measures length of overhang at each point transect.	Measuring rod and tape	None	F: Technician A: Hydrology/ Fisheries
	Vegetative Overhang (bank length) USDA Forest Service (1992)	1	<1	Measures length of overhang at each point transect.	Measuring rod and tape	None	F: Technician A: Hydrology/ Fisheries
f. Streambank Undercut	Streambank Undercut (at transect) Platts et al. (1987)	1	<1	Measures depth of undercut at each point transect.	Measuring rod	None	F: Technician A: Hydrology/ Fisheries
	Streambank Undercut (bank length) USDA Forest Service (1992)	1	<1	Measures length of bank with undercuts.	Measuring rod and tape	None	F: Technician A: Hydrology/ Fisheries

Attribute	Parameter/ Protocol	Frequency (time/year)	Collection Time (hours/site)	Comments	Equipment	Lab Costs* ($/sample)	Expertise**
III. Streambank Vegetation a. Vegetative Composition	Green Line Survey USDA Forest Service (1992)	1	1-2	Measures length of vegetation community types.	Measuring tape	None	F: Botany A: Botany/ Fisheries
b. Woody Species Regeneration	Woody Species Regeneration USDA Forest Service (1992)	1	1-4	Measures number of woody plants by age class.	Measuring tape and 2 meter rod	None	F: Technician A: Botany/Range Fisheries
c. Vegetative Utilization	Herbage Stubble Height Cook & Stubbendieck (1986)	1-3 depending on objective	1	Measured on top of bank after grazing and plant growth.	Pacing or measuring tape	None	F: Botany/Range A: Botany/Range
	Herbage Biomass Utilization Cage method Cook & Stubbendieck (1986)	1-3 depending on objective	1-2	Compares grazed plot to ungrazed plot.	Cage, hoop, clippers, weighing scales	None	F: Technician A: Botany/Range
	Woody Species Utilization Twig count Cook & Stubbendieck (1986)	1	<1	Measures percent of twigs browsed.	2 meter rod	None	F: Technician A: Botany/Range
IV. Biological Evaluation a. Macroinvertebrate	Macroinvertebrate Community Plafkin et al. (1989) Protocol III	1 (or seasonal)	1-3	RBP protocols are being locally refined.	Sampler, sieve, alcohol	$75 - $90	F: Technician A: Entomology
b. Fish Community	Fish Communities Plafkin et al. (1989) Protocol V	1 (or seasonal)	1-5	RBP protocols are being locally refined.	Electrofishing unit, nets, weighing scales	None	F: Fisheries A: Fisheries

* Cost per sample is based on 1990 economic valuation.
** Expertise is described for collection of data in the field, as well as for data analysis.

The protocols listed in Table 6.2 will be used to implement an M&E strategy for stream restoration projects that satisfies the primary objectives and tasks described below.

Objective 1: Riparian Enhancement

Task 1 *Implement riparian enhancement projects and uplands enhancement project in target watersheds.*
Riparian enhancement efforts may consist of reestablishing riparian buffer strips through riparian planting, use of bioengineering techniques for streambank stabilization, construction of exclusion fences and designated cattle crossings, and development of grazing management plans. Uplands enhancement projects may consist of increasing forest canopy closure through tree planting as a means to improve water retention, and rehabilitating roads to decrease sediment delivery. Project site locations are to be based on review of the prioritized list of critical riparian areas, location of previous enhancement activities, and landowner participation.

Products: Detailed project descriptions, signed landowner contracts, and completed enhancement projects based on site specific contract requirements.

Objective 2: Lateral Water Development

Task 1 *Develop sites that will provide high quality rearing and/or spawning habitat for cutthroat trout.*
Development of rearing habitat will involve the excavation of side channel ponds adjacent to the main channel. Connecting side channels will be engineered to divert an increasing amount of flow into backwater rearing areas as streamflow decreases during the summer months. Spawning habitat development will target degraded areas with a documented history of spawning behavior.

Products: Detailed project descriptions, signed landowner contracts and completed enhancement projects based on site specific contract requirements.

Objective 3: Water Storage Enhancement

Task 1 *Construct water storage structures based on recommendations developed in annual work plans.*

Products: Detailed project description, signed landowner contract, and completed enhancement project based on specific contract requirements.

Objective 4: Monitoring and Evaluation

Task 1 *Monitor the movement of adult and juvenile fish within watersheds targeted for restoration activities.*
This task will include installation and monitoring of migration traps, and tracking of adult cutthroat trout using radiotelemetry techniques.

Products: Quantitative estimate of adult and juvenile migrants based on catch per unit effort and recapture percentage. Identification of spawning areas and analysis of gravel quality and spawning success.

Task 2 *Population estimates of cutthroat trout will be calculated for mainstem and tributary reaches in the four target drainages.*

Products: Quantitative estimates of cutthroat trout population for each target watershed, with recommendations for adaptive management.

Task 3 *Monitor water temperature and stream flow at selected sites in each of the restoration target drainages.*

Temperature will be monitored continuously and stream flow will be measured at least once every two weeks during summer months.

Products: Analysis of the effects of water quality and quantity on the abundance and distribution of cutthroat trout.

Task 4 *Collection and analysis of aquatic macroinvertebrates according to EPA Rapid Bioassessment Protocol at regular intervals as needed.*

Products: Consultants report summarizing data analysis for eight biological metrics.

Task 5 *Ongoing and completed restoration projects will be evaluated to determine project effectiveness.*

Evaluations will include: 1) utilization of instream structures by cutthroat trout; 2) documentation of stability of instream structures; 3) growth and survival of riparian plantings; 4) riparian function analysis; and 5) quantification of landowner costshare.

Products: Annual report summarizing evaluations for all project activities.

6.2.2 Interim Harvest Opportunities

Objective **Determine pond program effectiveness**

Task 1 *Conduct Creel census and public opinion surveys for all ponds in the program each year.*

Product: Information gained will help determine angler use and attitude towards the project, and compensatory effectiveness of this action. Reports summarizing activities including pond construction, pond rehabilitation, angler use and trip satisfaction, stocking strategies, and overall effectiveness will be completed on an annual basis. Each year the effectiveness of the trout pond program will be reviewed in order to insure that the goals of the program are being realized.

Task 2 *Population estimates will be completed at each pond during October to determine how many fish were harvested during the year.*

6.2.3 Education and outreach Opportunities

Objective: **Develop and coordinate a natural resource based educational program for the Reservation community.**

Task 1 *Help kids develop interest in natural resource protection and formulate natural resource oriented career goals.*

Interact with area schools so that students and teachers become aware of, and participate in, restoration projects.

Products: A record will be kept describing participation with schools, community groups and individuals. When funding from other programs and/or grants are available, employment opportunities for Summer Interns will be available. Any such internships will produce tangible products directed towards public outreach and education.

Task 2 *Disseminate information on program activities and develop tools for receiving input from community members.*

Conduct watershed community meetings, workshops and other events. Additionally, where appropriate community groups exist, coordinate activities to provide information and integrate projects.

Product: Publish a quarterly newsletter.

Objective **Help coordinate a planning and management framework to facilitate communication among all parties involved and or interested in watershed restoration.**

Task 1 *Form functional watershed work groups comprised of private landowners, and agency, as well as non-agency interests, which will meet to discuss restoration and cooperative opportunities.*

Product: Provide a forum for local stakeholders to participate in restoration activities. Keep a record of interactions and develop a reporting system where participants are recognized for their cooperative efforts.

Task 2 *Coordinate restoration and management activities with other Tribal programs involved in natural resources management.*

Product: Ensure that restoration and management efforts are coordinated, and complimentary where appropriate. Work with other programs on Interdisciplinary Teams to build consensus on resource management issues that affect ecosystem restoration and recovery.

6.2.4 Supplementation Opportunities

Objective **Monitor and evaluate hatchery effectiveness in increasing the numbers of fish harvested and returning to spawn in Reservation waters.**

Task 1 *Enumerate the number of naturally produced migrating juveniles vs. hatchery produced juveniles.*
Operate outmigrant traps to monitor outmigration of wild and hatchery adfluvial fish. Fish captured will be sub-sampled to collect data on length, weight and origin (hatchery or natural). Trap efficiency will be determined through mark and recapture of known numbers of juvenile trout. Monitor resident fish species composition through snorkel count and/or electrofishing in index areas.

Product: Report containing information from migration traps including migration timing, number of hatchery vs. wild, habitat use by hatchery and wild fish.

Task 2 *Enumerate the number of migrating adults returning to spawn in Reservation waters.*
Install and monitor upstream traps to enumerate returns. Radio tag adult fish destined for return to treatment streams. As adult fish are detected and trapped at the weirs, radio tag and tack fish to determine movement pattern and length of time prior to spawning. Conduct cutthroat trout redd count surveys in spawning areas to determine spawner distribution. Collect biological information from population, as well as, determine origin. Collect and analyze the creel census data obtained from tributaries and Coeur d'Alene Lake.

Product: Report containing migration timing, spawning locations, numbers returning, trapping efficiency, hatchery vs. wild, habitat use by wild and hatchery adults.

Task 3 *Assess impacts of exotic species interactions with supplemented fish stocks in both Coeur d'Alene Lake and the target watersheds.*
Monitor interactions between resident trout and outplanted fish, as well as, interactions with other biota and other species of concern where applicable, by outmigrant traps, snorkel surveys, and electrofishing in watersheds where fish populations have been supplemented. Monitor interactions between outplanted fish and exotic species in Coeur d'Alene Lake. Conduct predator-pray analysis in littoral zones of Coeur d'Alene Lake affected by hydropower operations.

Product: Report detailing makeup of creel with hatchery to wild comparisons

Task 4 *Evaluate effectiveness of current harvest policies and enumerate hatchery contribution to creel.*
Increase harvest opportunities for fishers consistent with requirements of genetic, natural production, and experimentation objectives. Use selective and/or "status index harvest" policies to increase harvest opportunities for fishers. Provide a subsistence fishery of 0.5 fish/hr in catch-out trout ponds. Obtain rainbow trout creel condition factors ($K>152 \times 10^{-7}$)

Product: Report detailing makeup of creel with hatchery to wild comparisons

Task 5 *Maintain coordination with other tribal programs and activities.*
Monitor, review and comment on other agency activity in streams and watersheds where supplementation has been planned and take appropriate actions to protect watersheds crucial to the success of the project.

Product: Coordinated releases of hatchery fish

Task *Monitor and review compliance with hatchery operation manual for all hatchery related activity.*
Continue bacterial and viral sampling of adults during spawning operations. Continue proper fish culture techniques.

Product: Complete hatchery production evaluation forms. Report containing disease testing results.

Section 7.0

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APPENDIX A: RESULTS OF CHANNEL TYPE SURVEYS, STREAM REACH INVENTORY/CHANNEL STABILITY EVALUATION SURVEYS, AND RIFFLE ARMOUR STABILITY SURVEYS.

Summary of Lake Creek channel type surveys.

Reach ***Number***	*Reach* ***Location***	***Channel Type***	*Entrench-ment*	*Width/Depth Ratio*	*Sinuosity*	*Stream Gradient*	*Dominant Substrate*
1	Mainstem	C6	Slight	Mod-High	High	1	Silt
2	Mainstem	C4	Slight	Mod-High	High	1	Gravel
3	Mainstem	B3	Moderate	Moderate	Moderate	3-4	Cobble
4	Mainstem	C3	Slight	High	High	2	Cobble
5	Mainstem	B3	Moderate	Moderate	Moderate	3	Cobble
6	Mainstem	C4-C6	Slight	Mod-High	High	1	Gravel-Silt
7	Mainstem	E6	Slight	Very Low	Very High	1	Silt
8	Mainstem	E5	Sligth	Very Low	Very High	1	Sand
1	West Fork	E5-C5	Slight	Very Low	Very High	1	Sand
2	West Fork	E6	Slight	Very Low	Very High	1	Silt
3	West Fork	B4a	Moderate	Moderate	Moderate	5	Gravel

Summary of Benewah Creek channel type surveys.

Reach ***Number***	*Reach* ***Location***	***Channel Type***	*Entrench-ment*	*Width/Depth Ratio*	*Sinuosity*	*Stream Gradient*	*Dominant Substrate*
1	Mainstem	C3	Slight	High	High	2	Cobble
2	Mainstem	B2a	Moderate	Mod-High	Moderate	4	Boulder
3	Mainstem	C2b	Slight	Mod-High	High	2	Boulder
4	Mainstem	B3c	Moderate	High	Moderate	2	Boulder
5	Mainstem	C1b	Slight	Mod-High	High	4-5	Boulder
6	Mainstem	C3	Slight	Mod-High	High	1	Cobble
7	Mainstem	C3	Slight	Mod-High	High	1	Cobble
8	Mainstem	C6	Slight	Mod-High	High	1	Cobble
9	Mainstem	C5	Slight	Mod-High	High	<1	Sand
10	Mainstem	C6	Slight	Mod-High	High	1	Silt
11	Mainstem	E6	Slight	Very Low	Very High	<1	Silt
12	Mainstem	C5-C6	Slight	-----	High	<1	Sand-Silt
13	Mainstem	E4	Slight	Very Low	Very High	2	Gravel
1	West Fork	E4	Slight	Very Low	Very High	2-3	Gravel
2	West Fork	E3b	Slight	Mod-High	Very High	3-4	Cobble

Summary of Evans Creek channel type surveys.

Reach ***Number***	*Reach* ***Location***	***Channel Type***	*Entrench-ment*	*Width/Depth Ratio*	*Sinuosity*	*Stream Gradient*	*Dominant Substrate*
1	Mainstem	C6	Slight	-----	High	<1	Silt
2	Mainstem	C3	Slight	Very Low	High	1	Cobble
3	Mainstem	E3b	Slight	-----	Very High	3	Cobble
4	Mainstem	B3b	Moderate	-----	Moderate	--	Cobble
5	Mainstem	A4	Moderate	Moderate	Moderate	7	Cbl/Bld
6	Mainstem	A2a	High	Low	Low	10	Bld/Cbl
7	Mainstem	B3a	Moderate	Moderate	Moderate	9	Cobble
1	North Fork	B3a	Slight	Very Low	Moderate	8	Cbl/Bld
1	South Fork	A2	High	Low	Low	7-10	Gravel
2	South Fork	B3a	High	Low	Low	16	Bld/Cbl

Summary of Alder Creek channel type surveys.

Reach Number	***Reach Location***	***Channel Type***	***Entrench-ment***	***Width/Depth Ratio***	***Sinuosity***	***Stream Gradient***	***Dominant Substrate***
1	Mainstem	B3	Moderate	-----	Moderate	2	Cobble
2,3,4	Mainstem	A2-A3	High	Low	Low	3	Bld/Cbl
5,6	Mainstem	E3b	Slight	Very Low	High	2.5	Cobble
7	Mainstem	C3	Slight	Mod-High	High	1.5	Cobble
8	Mainstem	C6	Slight	Mod-High	High	<1	Silt
9	Mainstem	E3b	Slight	Very Low	Very High	1	Cobble
1	North Fork	E3b	Slight	Very Low	Very High	3	Cobble
2,3	North Fork	B3a-D3b	Moderate	Moderate	Moderate	2.5	Cobble
4	North Fork	B3a	Moderate	Low	Moderate	5	Cobble

Summary of Lake Creek Stream Reach Inventory and Channel Stability Evaluation Surveys.

	1993		***1994***	
Reach	*Score*	***Rating***	***Score***	***Rating***
1	113	Fair	73	Good
2	89	Fair	93	Fair
3	103	Fair	80	Fair
4	100	Fair	86	Fair
5	71	Good	101	Fair
6	101	Fair	95	Good
7	118	Poor	79	Fair
8	119	Poor	117	Poor
1WF	129	Poor	102	Fair
2WF	112	Fair	113	Fair
3WF	87	Fair	83	Fair

Summary of Evans Creek Stream Reach Inventory and Channel Stability Evaluation surveys.

	1993		*1994*	
Reach	*Score*	*Rating*	*Score*	*Rating*
1	***124***	***Poor***	***125***	***Poor***
2	***119***	***Poor***	***101***	***Fair***
3	***95***	***Fair***	***94***	***Fair***
4	***77***	***Fair***	***86***	***Fair***
5	***67***	***Good***	***73***	***Good***
6	***65***	***Good***	***72***	***Good***
7	***70***	***Good***		
1NF	***73***	***Good***	***83***	***Fair***
1SF	***86***	***Fair***	***84***	***Fair***
2SF	***66***	***Good***	***80***	***Fair***

Summary of Benewah Creek Stream Reach Inventory and Channel Stability Evaluation surveys.

	1993		*1994*	
Reach	*Score*	*Rating*	*Score*	*Rating*
1	94	Fair	83	Fair
2	74	Good	80	Fair
3	67	Good	67	Good
4	60	Good	78	Fair
5			48	Good
6	65	Good	59	Good
7	77	Fair	96	Fair
8	82	Fair	74	Good
9	122	Poor	90	Fair
10	100	Fair		
11	125	Poor	117	Poor
12	129	Poor	115	Poor
13	83	Fair	107	Poor
1WF	77	Fair	92	Fair
2WF	75	Good		

Summary of Alder Creek Stream Reach Inventory and Channel Stability Evaluation surveys.

	1993		*1994*	
Reach	*Score*	*Rating*	*Score*	*Rating*
1	88	Fair	76	Good
2	82	Fair	78	Fair
3	73	Good	80	Fair
4	73	Good	65	Good
5	82	Fair	81	Fair
6	53	Good	72	Good
7	79	Fair	90	Fair
8	128	Poor	118	Poor
9	103	Fair	80	Fair
1NF	58	Good	79	Fair
2NF	89	Fair	102	Fair
3NF	105	Fair	93	Fair
4NF	51	Good	78	Fair

Summary of Lake Creek Riffle Armour Stability Surveys.

Reach Number	*Sample Number*	*Index Value*		*Geometric Mean Diameter of Particles (mm)*		*Percent <4 mm Diameter*	
		1993	*1994*	*1993*	*1994*	*1993*	*1994*
2	1	62.0		69		28.4	
	2	78.1	96.8	96	142	34.0	3.1
	3	48.0	88.0	98	139	10.4	5.9
3	1	75.8	80.3	119	107	21.3	10.8
	2	58.0	77.9	150	134	19.6	11.3
	3	65.8	52.0	165	152	11.2	19.4
4	1	78.0	69.1	153	148	24.6	17.5
	2	67.4		120		26.6	
	3	72.9	69.6	133	134	40.7	9.5
5	1	52.6	69.5	94	171	37.3	15.7
	2	59.1	82.5	144	176	16.8	14.4
	3	33.6	66.9	101	173	19.9	26.9
6	1	74.2	81.4	130	151	34.5	34.0
	2	74.6	78.3	85	134	54.5	22.5
	3	71.6	84.5	115	142	55.5	23.1
7	1	80.4	68.0	123	113	46.7	43.1
	2	96.1	88.6	98	139	81.2	61.7
	3	90.6	95.8	86	121	83.7	31.7
2WF	1	62.6		61		17.5	
	2	62.6		61		17.7	
	3	66.0		53		30.0	

Summary of Benewah Creek Riffle Armour Stability Surveys.

Reach Number	*Sample Number*	*Index Value*		*Geometric Mean Diameter of Particles (mm)*		*Percent <4 mm Diameter*	
		1993	*1994*	*1993*	*1994*	*1993*	*1994*
1	1	79.5	89.8	130	130	26.4	24.8
	2	69.3	68.9	133	175	8.7	12.3
	3	82.4	87.1	136	152	1.5	27.3
2	1		24.1		129		5.3
	2		67.1		126		11.7
	3		38.9		132		14.7
3	1	52.3	2.7	126	135	11.3	2.4
	2	44.7	43.0	131	152	6.5	6.7
	3	55.5	86.7	162	138	6.8	9.4
4	1	38.2	82.0	97	124	2.5	11.0
	2	53.3	78.8	114	121	8.3	12.7
	3	45.5	83.4	113	131	6.9	11.1
6	1	44.8	66.8	127	148	10.0	15.3
	2	43.0	28.9	107	129	13.5	9.8
	3	62.3	85.7	134	122	9.0	10.6
7	1	60.2	72.0	142	94	14.5	17.2
	2	27.0	69.6	79	117	13.3	9.3
	3	45.1	92.7	127	117	11.2	20.2
8	1	41.6	70.5	108	164	9.8	27.5
	2	33.0	76.2	63	123	5.0	8.2
	3	72.4	68.9	154	124	9.2	8.5
13	1	49.5		78		20.1	

Summary of Evans Creek Riffle Armour Stability Surveys.

Reach Number	*Sample Number*	*Index Value*		*Geometric Mean Diameter of Particles (mm)*		*Percent <4 mm Diameter*	
		1993	*1994*	*1993*	*1994*	*1993*	*1994*
2	1	75.2	91.4	44	143	35.7	3.5
	2	39.8	97.5	71	139	2.0	10.3
	3	62.5	89.4	82	154	4.5	6.1
3	1	37.3	84.0	87	130	11.8	24.2
	2	82.2		113		17.3	
	3	59.6	91.5	94	141	23.2	13.5
4	1	59.1	90.3	95	172	11.5	25.8
	2	61.0	92.6	76	183	10.0	22.6
	3	56.7	84.6	81	137	16.0	17.0
5	1	42.5	60.0	73	121	20.9	16.5
	2	51.8	61.9	77	113	23.3	13.1
	3	31.4	64.3	76	135	20.8	11.1
1NF	1	63.4	64.8	71	54		37.9
	2	84.6	78.3	93	79		39.5
	3	71.8		75			

Summary of Alder Creek Riffle Armour Stability Surveys.

Reach Number	*Sample Number*	*Index Value*		*Geometric Mean Diameter of Particles (mm)*		*Percent <4 mm Diameter*	
		1993	*1994*	*1993*	*1994*	*1993*	*1994*
1	1	31.9	58.0	57	135	7.7	11.3
	2	37.9	68.6	58	141	7.1	11.1
	3	28.5	39.2	62	132	11.0	6.2
3	1	33.4	62.2	66	161	13.9	10.1
	2	24.8	65.6	62	163	5.1	10.3
	3	15.6	50.0	54	156	2.8	11.1
5	1	27.8	59.7	46	173	6.5	9.2
	2	40.3	46.2	52	146	11.0	11.4
	3	30.5	71.1	47	167	11.2	7.6
7	1	83.2	68.8	123	96	19.8	22.3
	2	66.6	87.8	83	154	1.6	14.9
	3	90.8	55.5	66	123	25.6	16.9
1NF	1	55.0	80.1		107		32.3
	2	79.4	85.8	64	107	23.5	26.9
	3	50.7	72.1	43	98	20.2	30.5
2NF	1		69.3		58		36.1
3NF	1	65.9	45.6	43	47	29.4	22.9
	2	76.7	65.6	48	43	30.1	34.6
	3		46.2		50		19.7
4NF	1	45.0		42		22.0	
	2	39.5		45		15.1	
	3	37.5		30		21.6	

APPENDIX B: GENERALIZED LANDOWNER AGREEMENT

AGREEMENT AND LICENSE TO ENTER

This Agreement is entered into between the Coeur d'Alene Tribe, through its Natural Resources Department, hereinafter referred to as "Natural Resources Department" and *Landowner Name*, hereinafter referred to as the "Landowner".

In consideration of the mutual promises contained in this Agreement, the parties agree as follows:

l. Grant of License

Natural Resources Department is engaging in restoration projects to improve fish habitat and water quality in a number of watersheds on the Reservation. The Landowner’s property is located in the Lake Creek watershed, and is a good candidate for such restoration.

Natural Resources Department staff members and contractors may enter the real property of Landowner to plant, maintain, and monitor the riparian habitat improvements as shown and described in exhibit A. Contractors are those persons who have been designated in writing by the Natural Resources Department as authorized to conduct work on behalf on the Tribe.

II. Terms of License

This license shall continue for a term of twenty-five (25) years with an optional review of the Agreement every two (2) years following the first year of initial execution. Review of the Agreement may be initiated by the either the Natural Resources Department or the Landowner. The Agreement may be modified provided both parties sign the revised Agreement.

III. Description of Property

The rights granted to the Natural Resources Department hereunder shall inure to the benefit of the Natural Resources Department only. The rights conferred upon the Department shall run with the land against all interest holders and lessors of said property known as the *Landowner Name* property and more fully described in exhibit A attached hereto and incorporate herein.

IV. Conditions

Natural Resources Department agrees to plant and monitor growth and survival of trees and shrubs described in exhibit A for twenty-five (25) years following the signing of this Agreement.

Landowner shall hold Natural Resources Department harmless for any damages that may arise as a result of the Department’s use of the property. However, the Natural Resources Department will agree to negotiate in good faith to repay Landowner for any real damages, which may result from the negligent use of the property up to any amounts payable under its general liability insurance and property loss insurance policy. Negligence is defined as the failure to do something with reasonable care. Reasonable care is defined as care that persons of ordinary prudence exercise under similar circumstances.

Natural Resources Department shall comply with all applicable tribal, federal and other laws and comply with the conditions of any permit required by any federal agency to perform any task agreed to herein.

Nothing in this Agreement shall be construed as a waiver of sovereign immunity of the Coeur d'Alene Tribe or its agencies or departments.

The Natural Resources Department shall maintain through the Coeur d'Alene Tribe, liability insurance in the amount of at least 100,000 dollars and property loss and damage insurance covering the value of Department property during all times this Agreement is in effect.

V. Responsibility of Landowner

Landowner agrees not to damage, destroy, or remove deciduous trees and shrubs planted in the riparian zone by the Natural Resource Department for the duration of this Agreement.

Pre-commercial or commercial thinning may be considered to mitigate fire hazard as well as maximize tree growth and health if both parties are in agreement. A signed modification to this agreement will be needed prior to initiation of any such management action by Landowner.

A need to conduct pre-commercial or commercial thinning will be mitigated by the need to provide continued large organic debris, stream shading, soil stabilization, wildlife cover, and water filtering effects of vegetation in the stream protection zone. Specific considerations will include, but are not limited to the following:

i) Leave hardwood trees, shrubs, grasses, and rocks wherever they afford shade over the stream channel or maintain the integrity of the soil near the streambanks.

ii) Leave at least 75 percent of the current shade over the stream channel.

iii) Standing trees, including conifers and snags will be left within 75 feet of the ordinary high water mark on each side of the stream in the following minimum numbers per 1000 feet of stream.

iv) Snags will be counted as standing trees in each diameter class if snag height exceeds 1.5 times the distance between the snag and the stream’s ordinary high water mark.

Tree Diameter (DBH)	Minimum Number Standing Trees/1000 Feet (each side)
0 - 7.9”	200
8 - 11.9”	60
12 - 19.9”	40
20” +	8

Landowner shall not allow livestock to graze within the bounds of the riparian zones for at least five years from the time of planting. After this time an agreement between the two parties for a rotation-grazing plan may be set up.

If encroachment of cattle occurs within the riparian zone as a result of Landowner's negligence or failure to contain said cattle, the Landowner shall pay the actual cost of replanting and protecting said riparian zone.

Landowner agrees to notify the Natural Resources Department in writing 90 days prior to any attempt to transfer rights and interest in the said property. If transfer of the rights and interest in the property occurs before expiration of the license term, Landowner agrees to make the obligations of this agreement known to the transferee. This Agreement will be presented to the transferee as binding, but the transferee will have the option to negotiate in good faith modified operation and maintenance obligations with the Natural Resources Department in a separate agreement, if necessary. However, should a new agreement not be reached, this agreement shall still apply until a new agreement is made.

This Agreement shall inure to the benefit of and bind the Landowner and her/his heirs, assigns, interest holders and lessors.

In witness whereof, each party to this Agreement has caused it to be executed near Plummer, Idaho, on the date indicated

______________________________________ ___________________

Landowner/Personal Representative **Date**

I,_________________, a notary public, do hereby certify that on ____ day of ____, 1998, personally appeared ____________________, who, being by me first duly sworn, declared that he/she signed the foregoing document that the statements therein contained are true to the best of his/her knowledge and belief.

____

Notary Public for State of ____________
Commission Expires:________________

______________________________________ ___________________

Landowner/Personal Representative **Date**

I,_________________, a notary public, do hereby certify that on ____ day of ____, 1998, personally appeared ____________________, who, being by me first duly sworn, declared that he/she signed the foregoing document that the statements therein contained are true to the best of his/her knowledge and belief.

____

Notary Public for State of ____________
Commission Expires:________________

____ ___________________

Natural Resources Department Representative **Date**

I,_________________, a notary public, do hereby certify that on ____ day of ____, 1998, personally appeared ____________________, who, being by me first duly sworn, declared that he/she signed the foregoing document that the statements therein contained are true to the best of his/her knowledge and belief.

____

Notary Public for State of_____________
Commission Expires:________________

JOINT APPLICATION FOR PERMIT
U.S. ARMY CORPS OF ENGINEERS
IDAHO DEPARTMENT OF WATER RESOURCES
IDAHO DEPARTMENT OF LANDS

SEPARATE PERMIT DECISIONS MUST BE RECEIVED FROM BOTH THE STATE OF IDAHO AND THE CORPS OF ENGINEERS PRIOR TO START OF WORK

The Department of the Army permit program is authorized by Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act. These laws require permits authorizing structures and work in or affecting navigable waters of the United States and the discharge of dredged or fill material into waters of the United States, including their adjacent wetlands. State permits are required under the State of Idaho, Stream Channel Protection Act (Title 42, Chapter 38, Idaho Code) and the Idaho Lake Protection Act, Section 58-142 et. seq, Idaho Code. This application will meet the requirements of the above agencies.

1. Corps of Engineers # ______ Date Received ______	2. State of Idaho # ______ Date Received ______ $20 Rec'd By: ______ Receipt # ______

PLEASE TYPE OR PRINT

3. Applicant John Smith
Mailing Address 1799 Main Street
Avery, ID 83802
Work Phone (Area 208 555-9675 Home (Area 208) 555-4663
Fax Number 208-555-1212

4. Authorized Agent ABC Construction
Mailing Address 512 Main Street
Stanley, ID 83278
Work Phone (Area 208 555-4344 Home (Area)

5. Location where proposed activity exists or will occur.

Waterway West Fork Bluff Creek

Tributary of: St. Joe River

Assessor's Desc. (Tax No. or Subdivision, Lot & Block No.)
* ______ ______ ______ *(See instructions)

near Avery (In/near city or town) Shoshone (County) ID (State)

NW 1/4 (1/4 1/4) 13 (Section) 44N (Township) 7E (Range) or

83802 (Zip Code) Shoshone County (Local jurisdiction (city or county))

UTM Coordinate Grid Zone 11 (Zone) N 5224140 (Northing) E 611700 (Easting)

6. Describe the proposed activity. Provide a general description of the proposed work including all discharges of fill material and any structures such as piers, floats, boat lifts, bulkheads, and cofferdams.

Place clean, rock riprap along approximately 800 feet of bank. Boulder size will be between 12 and 18 inches in diameter.

Describe construction methods and equipment:
Rock will be placed from the top of the bank by a backhoe.

List all soil series located at project site, and indicate if any are on the county's hydric soils list:

Length of project along the stream or extension into lake or reservoir: 800 Feet

Will material be placed waterward of ordinary high water mark? Yes If yes, volume: 780 (cubic yards)
(BOTH TEMPORARY AND PERMANENT)

Will material be placed in wetlands? No If yes, total area: ______ (acres)

Type and composition of fill material: riprap (i.e. sand, etc.) Material Source: local quarry

Will excavation or dredging be required? yes If yes, volume: 80 (cubic yards) Composition gravel

Disposal site for excavated material: off-site/upland Method of excavation: backhoe

Stream gradient: 2%

Method of controlling turbidity and/or sedimentation: Construct during summer low flows (July-August)

7. Size and flow capacity of proposed bridge or culvert and area of drainage served (sq. miles): (Idaho Department of Water Resources requirement.)

N/A

NPW 304
Feb 94 (REV)

6

IDWR Form 3804-B
Feb 94 (REV)

8. Preparation of drawings. One set of original or good quality reproducible drawings must be attached to this application. NOTE: DRAWINGS NO LARGER THAN 8-1/2 X 11 INCHES IN SIZE. See the instruction pamphlet for instructions and a checklist for completing the drawings. Include photographs of the project site mounted on 8-1/2 x 11 sheets.

9. Purpose and intended use: Commercial ______ Public X Private ______ Other ______ Describe Bank Protection

Necessity and justification for project Banks are being eroded by high flows.

10. Proposed Starting Date August 15, 1994 Estimated Duration 1 week

11. If any portion of the activity is complete, indicate month and year of completion ______
Indicate the existing work on the drawings.

12. Names, addresses, and telephone numbers of adjoining property owners, lessees, etc., whose property also adjoins the waterway

Bob Hart (208) 555-4235	Simon Long (208) 555-8255	
Route 1, Box 543	Route 3, Box 97	
Avery, ID 83802	Avery, ID 83802	

☐ Check here if the alteration is located on endowment lands administered by the Idaho Department of Lands

13. LEGAL OWNER IF OTHER THAN APPLICANT N/A

Mailing Address ______ City, State, Zip Code ______

Phone Area Work(____) ______ Area Home(____) ______

14. List other applications, approvals, or certifications from other Federal, interstate, state, or local agencies for any structures, constructions, discharges, deposits, or other activites described in the application.

Issuing Agency	Type of Approval	Identification No.	Date of Application	Date of Approval
Dept. of Water Resources	Stream Channel Alteration	91-S-999	5/5/94	

15. Has any agency denied approval for the activity described herein or for any activity directly related to the activity described herein? Yes ______ No X
(If "Yes" explain)

16. Remarks or additional information: From Highway 97 turn west onto Dale Road, proceed 1.2 miles, turn right into drive at #2397. Brown house with green trim.

17. Application is hereby made for a permit or permits to authorize the activities described herein. I certify that I am familiar with the information contained in this application, and that to the best of my knowledge and belief, such information is true, complete, and accurate. I further certify that I possess the authority to under take the proposed activities. I hereby grant to the agencies to which this application is made, the right to come upon the above-described location to inspect the proposed or completed work.

5/5/94 John Smith
Date Signature of Applicant **(ORIGINAL SIGNATURE REQUIRED)**

19. If an authorized agent is to be designated, Item 4 and the following information should be completed.

I hereby designate ABC Construction to act as my agent in matters related to this permit application. I understand that if a Federal permit is issued, I must sign the permit.

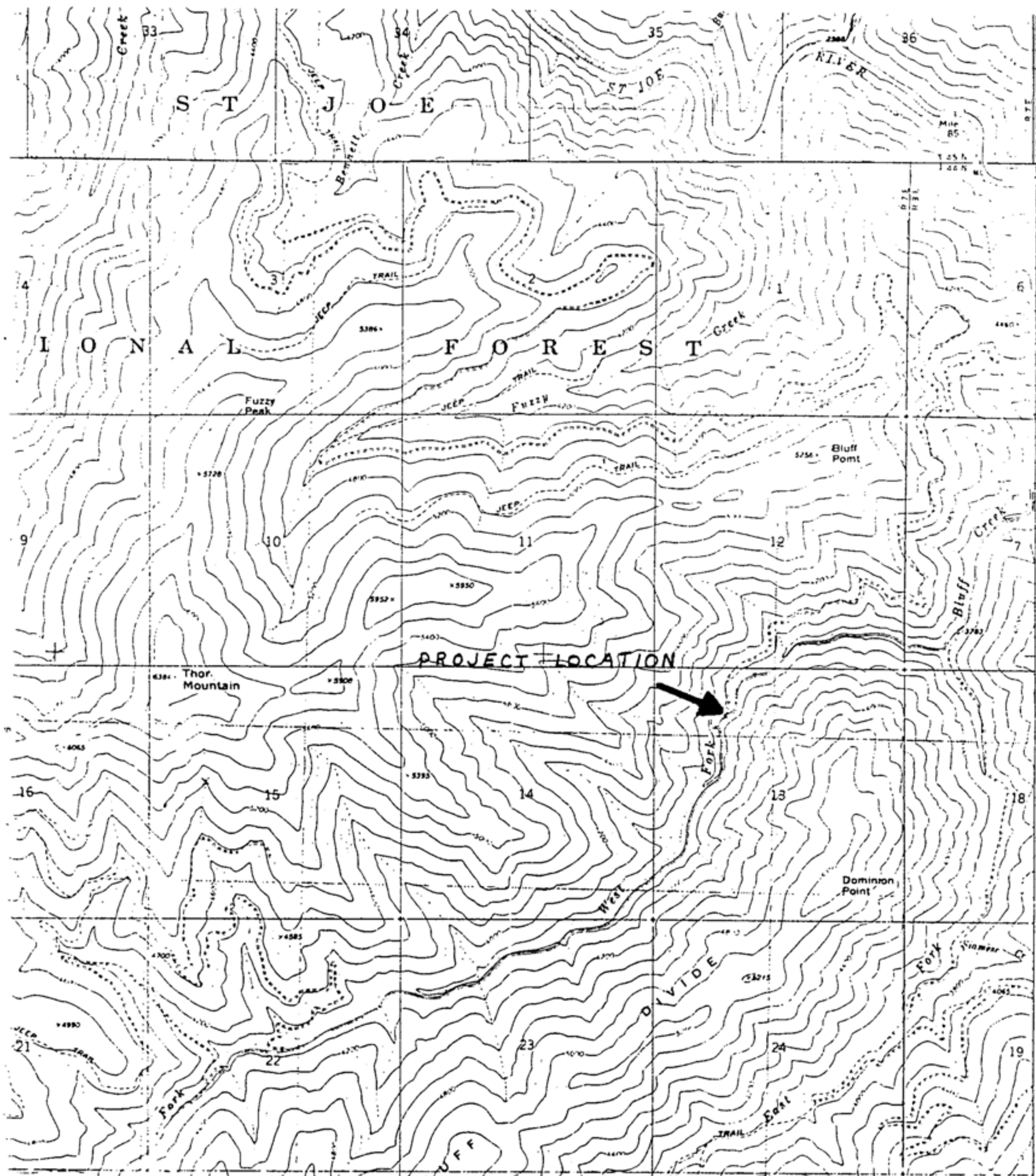
5/5/94 William Jones, ABC CONSTRUCTION John Smith
Date Original Signature of Authorized Agent Original Signature of Applicant

18 U.S.C. Section 1001 provides that: Whoever, in any manner within the jurisdiction of any department or agency of the United States knowingly falsifies, conceals, or covers up by any trick, scheme, or device a material fact or makes any false, fictitious, or fraudulent statements or representations or makes or uses any false writing or document knowing same to contain any false, fictitious, or fraudulent statement or entry, shall be fined not more than $10,000 or imprisoned not more than 5 years or both. Do not sent a Federal permit processing fee with this application. The appropriate fee will be assessed when a permit is issued.

DO NOT SEND FEDERAL PROCESSING FEE WITH APPLICATION

NPW Form 304
Feb 94 (Rev)

IDWR Form 3804-B
Feb 94 (REV)

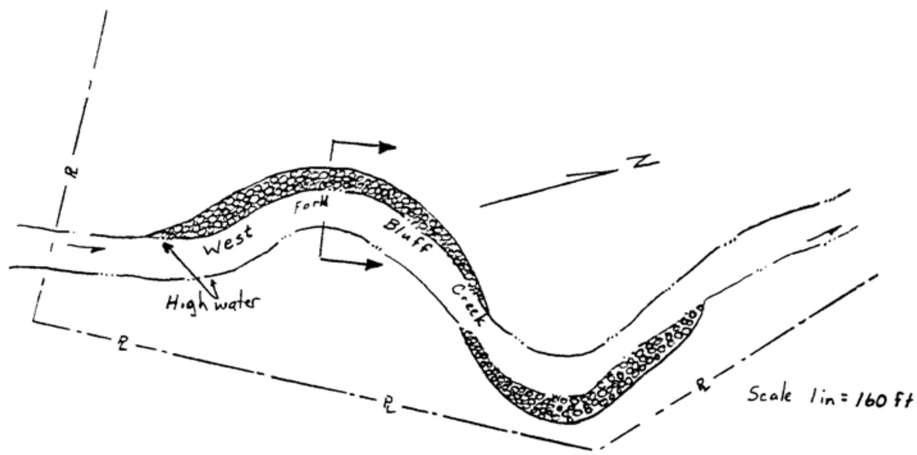


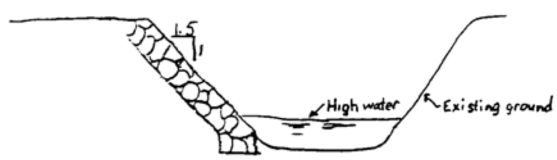
VICINITY MAP

TAKEN FROM USGS THOR MTN

IN: West Fork Bluff Creek
IN/NEAR Avery
Shoshone COUNTY, Idaho
DATE: 5/5/94 SHEET 1 OF 2
APPLICATION BY: John Smith

8





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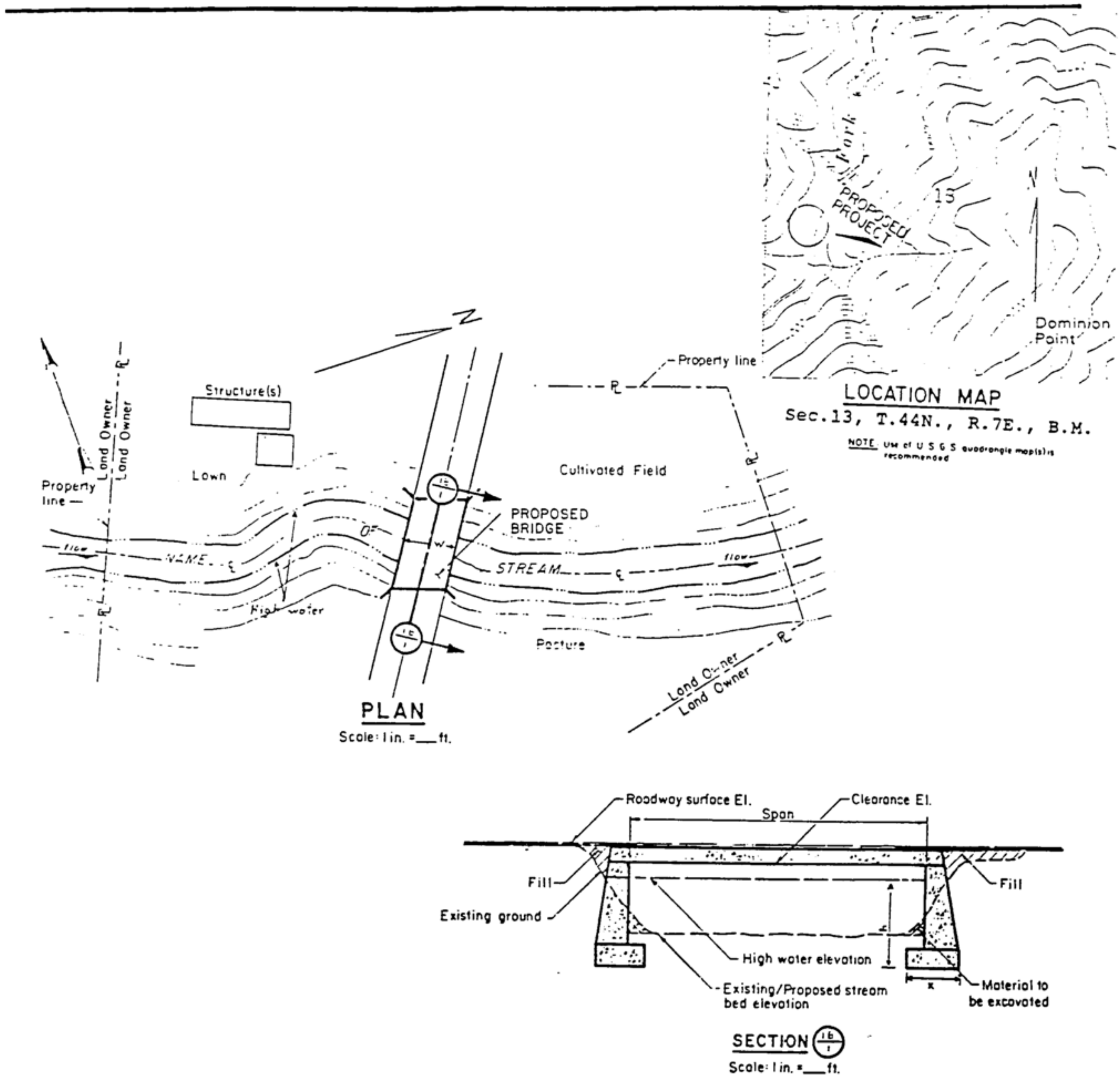
IN/NEAR Avery
Shoshone COUNTY, Idaho
DATE: 5/5/94 SHEET 2 OF 2
APPLICATION BY: John Smith

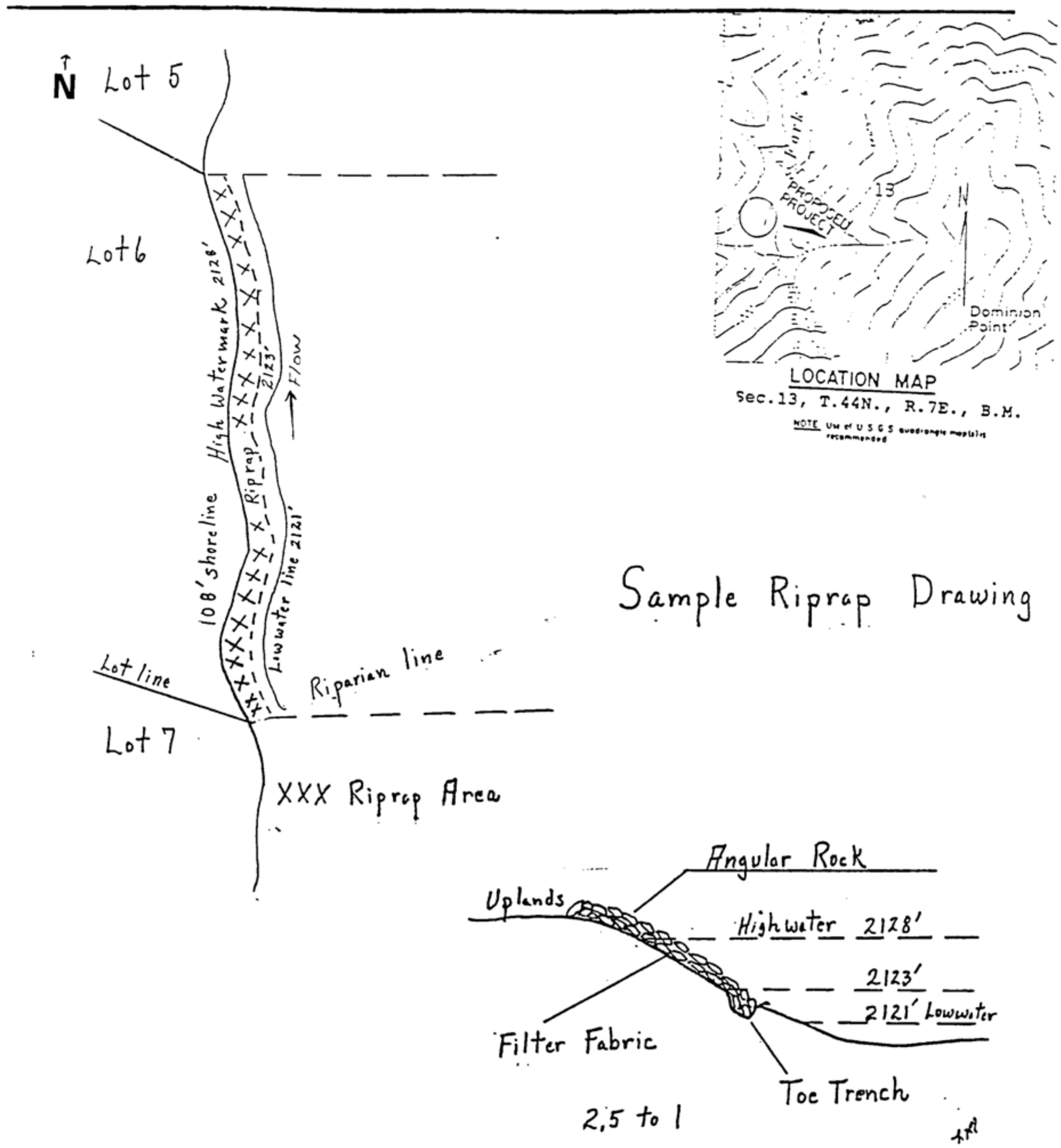
9



NPW No.
APPLICANT
Waterway
County, Idaho
Sheet of
Date

SAMPLE PLAN NO. 1

10



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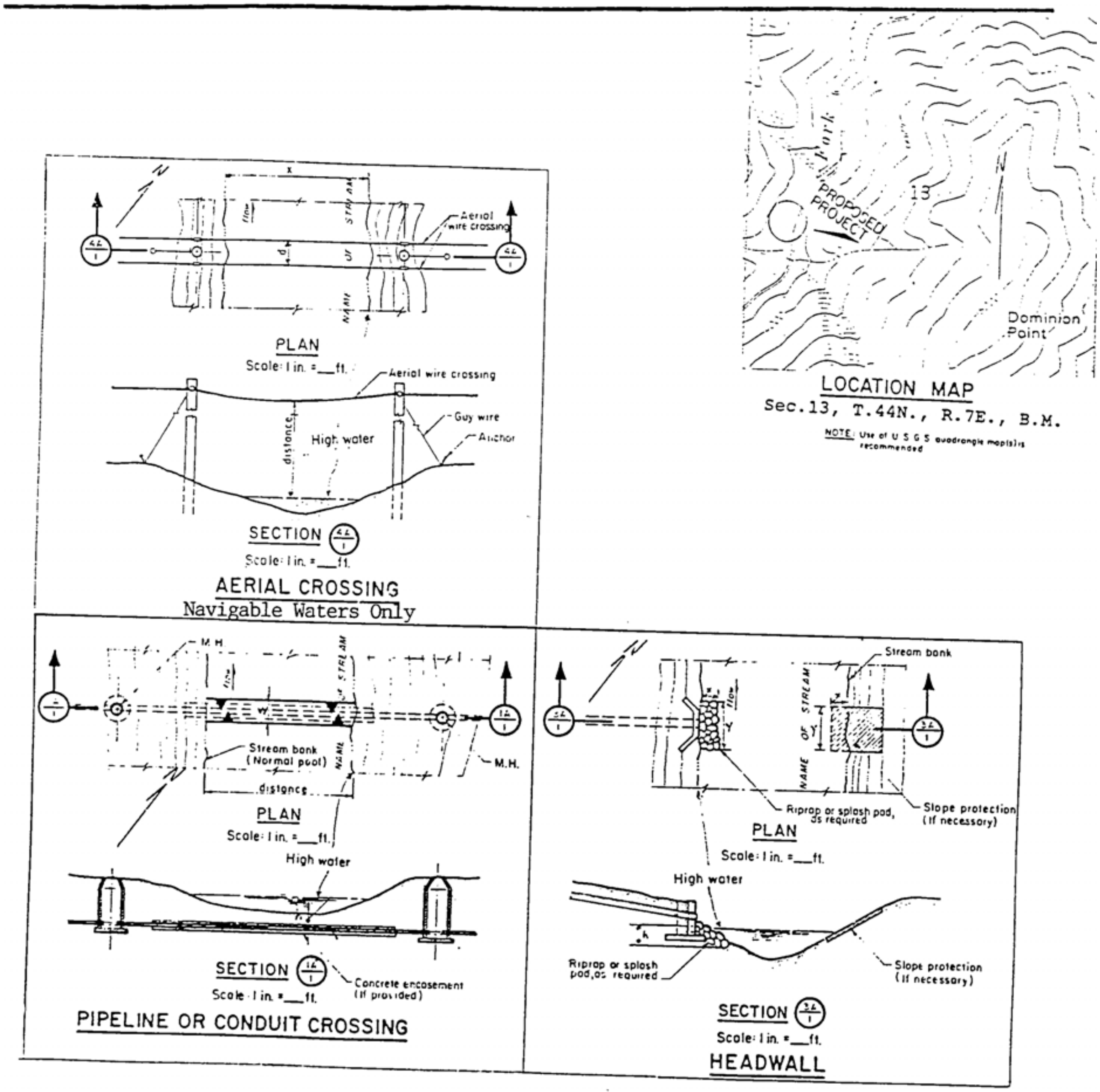
Waterway
County, Idaho
Sheet of
Date

SAMPLE PLAN NO. 2

11

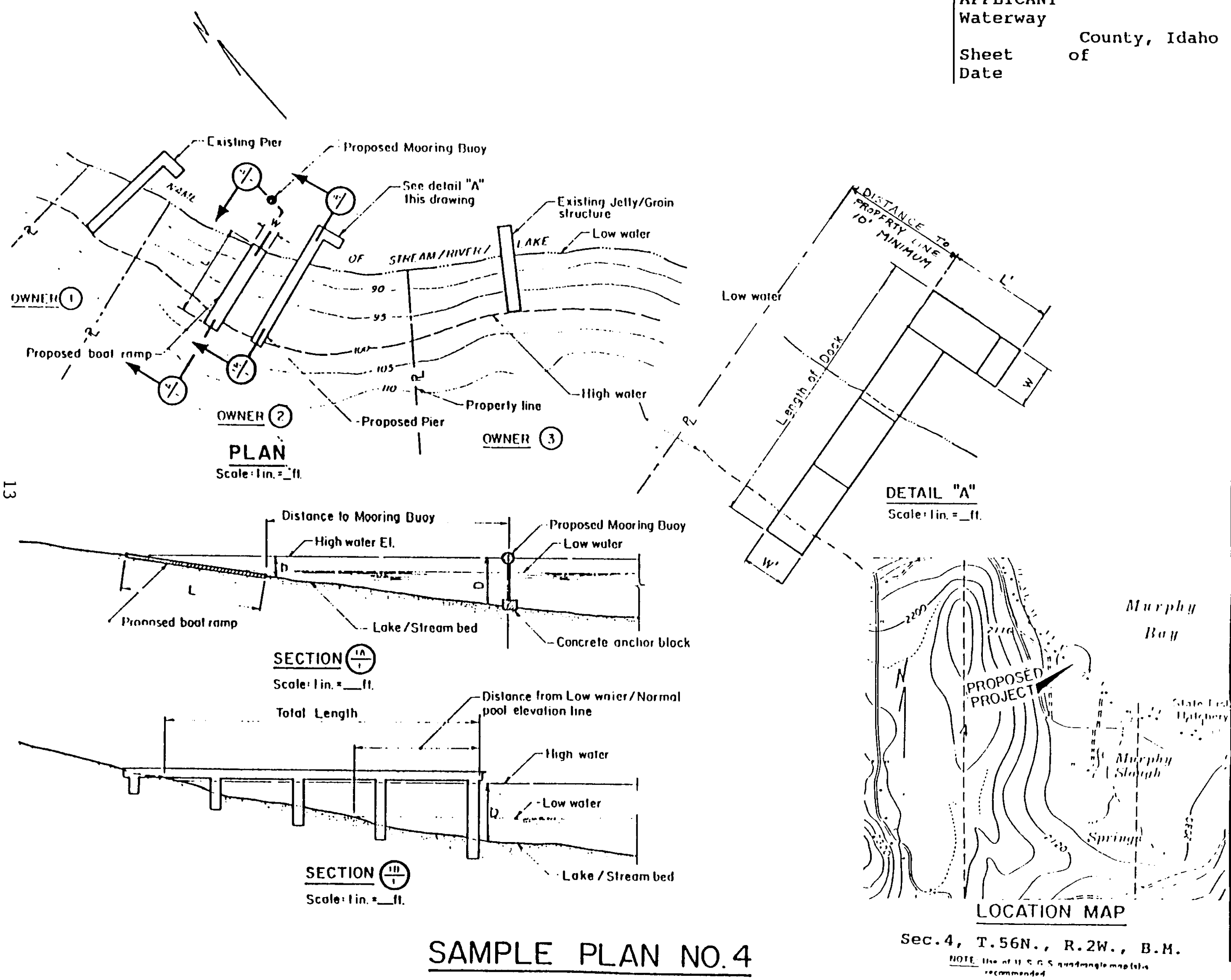


SAMPLE PLAN NO. 3

NPW No.
APPLICANT
Waterway
County, Idaho
Sheet of
Date

12

NPW No.
APPLICANT
Waterway
County, Idaho
Sheet of
Date



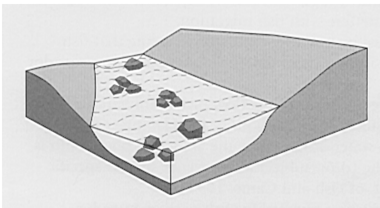
SAMPLE PLAN NO. 4

13

APPENDIX D: RESTORATION TECHNIQUES

INSTREAM PRACTICES

Boulder Clusters



Groups of boulders placed in the base flow channel to provide cover, create scour holes, or areas of reduced velocity.

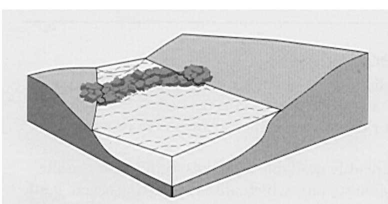
Applications and Effectiveness

- Can be used in most stream habitat types including riffles, runs, flats, glides and open pools.
- Greatest benefits are realized in streams with average flows exceeding 2 feet per second.
- Group placements are most desirable. Individual boulder placement might be effective in very small streams.
- Most effective in wide, shallow streams with gravel or rubble beds.
- Also useful in deeper streams for providing cover and improving sub-strate.
  Added erosive forces might cause channel and bank failures.
  - Not recommended for streams which are aggrading or degrading
- Not recommended for sand bed (and smaller bed materials) streams because they tend to get buried.
- May promote bar formation in streams with high bed material load.

For More Information

Consult the following references: Nos. 11, 13, 21, 34, 39, 55, 60, 65, 69.

Weirs or Sills



Log, boulder, or quarrystone structures placed across the channel and anchored to the streambank and/or bed to create pool habitat, control bed erosion, or collect and retain gravel.

Applications and Effectiveness

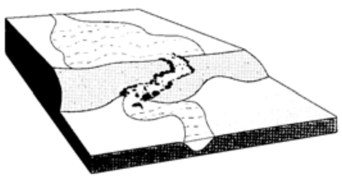
- Create structural and hydraulic diversity in uniform channels.
- If placed in series, they should not be so close together that all riffle and run habitat is eliminated.
- Pools will rapidly fill with sediment in streams transporting heavy bed material loads.
- Riffles often are created in downstream deposition areas.
- Weirs placed in sand bed streams are subject to failure by undermining.
- Potential to become low flow migration barriers.
- Selection of material is important.
  - Boulder weirs are generally more permeable than other materials and might not perform well for funneling low flows. Voids between boulders may be chinked with smaller rock and cobbles to maintain flow over the crest.
  - Large, angular boulders are most desirable to prevent movement during high flows.
  - Log weirs will eventually decompose.
- Design cross channel shape to meet specific need(s).
  - Weirs placed perpendicular to flow work well for creating backwater.
  - Diagonal orientations tend to redistribute scour and deposition patterns immediately downstream.
  - Downstream 'Vs' and 'U's' can serve specific functions but caution should be exercised to prevent failures.
  - Upstream 'V's' or 'U's' provide mid-channel, scour pools below the weir for fish habitat, resting, and acceleration maneuvers during fish passage.
  - Center at lower elevation than sides will maintain a concentrated low flow channel.

For More Information

Consult the following references: Nos. 11, 13, 44, 55, 58, 60, 69.

INSTREAM PRACTICES

Fish Passages



Any one of a number of instream changes which enhance the opportunity for target fish species to freely move to upstream areas for spawning, habitat utilization, and other life functions.

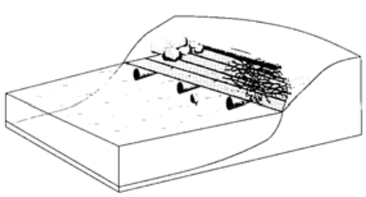
Applications and Effectiveness

- Can be appropriate in streams where natural or human placed obstructions such as waterfalls, chutes, logs, debris accumulations, beaver dams, dams, sills, and culverts interfere with fish migration.
- The aquatic ecosystem must be carefully evaluated to assure that fish passages do not adversely impact other aquatic biota and stream corridor functions.
- Slopes, depths and relative positions of the flow profile for various flow ranges are important considerations. Salmonids, for example, can easily negotiate through vertical water drops where the approach pool depth is 1.25 times the height of the (drop subject to an overall species-specific limit on height) (CA Dept. of Fish and Game, 1994).
- The consequences of obstruction removal for fish passage must be carefully evaluated. In some streams, obstructions act as barriers to undesirable exotics (e.g. sea lamprey) and are useful for scouring and sorting of materials, create important backwater habitat, enhance organic material input, serve as refuge for assorted species, help regulate water temperature, oxygenate watel and provide cultural resources.
- Designs vary from simple to complex depending on the site and the target species.

For More Information

Consult the following references: Nos., 11, 69, 81.

Log/Brush/Rock Shelters



Logs, brush, and rock structures installed in the lower portion of streambanks to enhance fish habitat, encourage food web dynamics, prevent streambank erosion, and provide shading.

Applications and Effectiveness

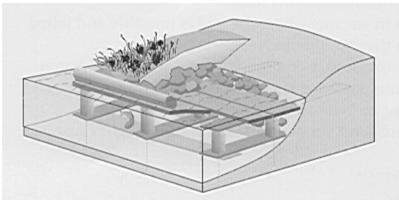
- Most effective in low gradient stream bends and meanders where open pools are already present and overhead cover is needed.
- Create an environment for insects and other organisms to provide an additional food source.
- Can be constructed from readily available materials found near the site.
- Not appropriate for unstable streams which are experiencing severe bank erosion and/or bed degradation unless integrated with other stabilization measures.
- Important in streams where aquatic habitat deficiencies exist.
- Should, where appropriate, be used with soil bioengineering systems and vegetative plantings to stabilize the upper bank and ensure a regenerative source of streambank vegetation.
- Not generally as effective on the inside of bendways.

For More Information

Consult the following references: Nos. 11, 13, 39, 55, 65.

INSTREAM PRACTICES

Lunker Structures



Cells constructed of heavy wooden planks and blocks which are imbedded into the toe of streambanks at channel bed level to provide covered compartments for fish shelter, habitat, and prevention of streambank erosion.

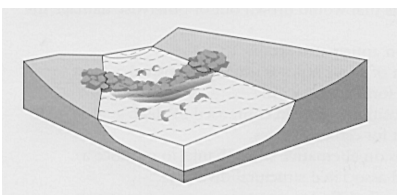
Applications and Effectiveness

- Appropriate along outside bends of streams where water depths can be maintained at or above the top of the structure.
- Suited to streams where fish habitat deficiencies exist.
- Should, where appropriate, be used with soil bioengineering systems and vegetative plantings to stabilize the upper bank and ensure a regenerative source of streambank vegetation.
- Are often used in conjunction with wing deflectors and weirs to direct and manipulate flows.
- Are not recommended for streams with heavy bed material loads.
- Most commonly used in streams with gravel-cobble beds.
- Heavy equipment may be necessary for excavating and installing the materials.
- Can be expensive.

For More Information

Consult the following references: Nos. 10, 60, 65, 85.

Migration Barriers



Obstacles placed at strategic locations along streams to prevent undesirable species from accessing upstream areas.

Applications and Effectiveness

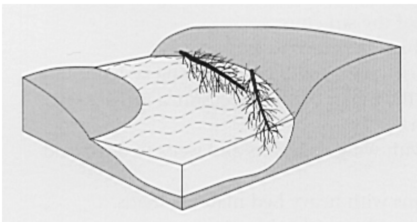
- Effective for specific fishery management needs such as separating species or controlling nuisance species by creating a barrier to migration.
- Must be carefully evaluated to assure migration barriers do not adversely impact other aquatic biota and stream corridor functions.
- Either physical structures or electronic measures can be used as barriers.
  - Structures can be installed across most streams, but in general they are most practical in streams with baseflow depth under two feet and widths under thirty feet.
  - Temporary measures such as seines can also be used under the above conditions.
  - Electronic barriers can be installed in deeper channels to discourage passage. Electronic barrier employs lights, electrical pulses or sound frequencies to discourage fish from entering the area. This technique has the advantage of not disturbing the stream and providing a solution for control in deep water.
- Barriers should be designed so that flood flows will not flank them and cause failures.

For More Information

Consult the following references: Nos. 11, 55.

INSTREAM PRACTICES

Tree Cover



Felled trees placed along the streambank to provide overhead cover, aquatic organism substrate and habitat, stream current deflection, scouring, deposition, and drift catchment.

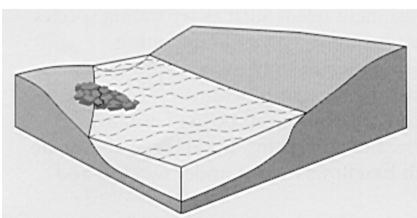
Applications and Effectiveness

- Can provide benefits at a low installation cost.
- Particularly advantageous in streams where the bed is unstable and felled trees can be secured from the top of bank.
- Channels must be large enough to accommodate trees without threatening bank erosion and limiting needed channel flow capacity.
- Design of adequate anchoring systems is necessary.
- Not recommended if debris jams on downstream bridges might cause subsequent problems.
- Require frequent maintenance.
- Susceptible to ice damage.

For More Information

Consult the following references: Nos. 11, 55, 69.

Wing Deflectors



Structures that protrude from either streambank but do not extend entirely across a channel. They deflect flows away from the bank, and scour pools by constricting the channel and accelerating flow.

Applications and Effectiveness

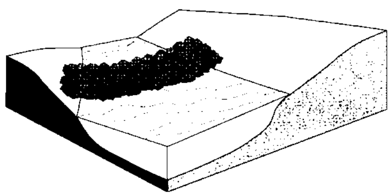
- Should be designed and located far enough downstream from riffle areas to avoid backwater effects that would drown out or otherwise damage the riffle.
- Should be sized based on anticipated scour.
- The material washed out of scour holes is usually deposited a short distance downstream to form a bar or riffle area. These areas of deposition are often composed of clean gravels that provide excellent habitat for certain species.
- Can be installed in series on alternative streambanks to produce a meandering thalweg and associated structural diversity.
- Rock and rock-filled log crib deflector structures are most common.
- Should be used in channels with low physical habitat diversity, particularly those with a lack of stable pool habitat.
- Deflectors placed in sand bed streams may settle or fail due to erosion of sand, and in these areas a filter layer or geotextile might be needed underneath the deflector.

For More Information

Consult the following references: Nos. 10, 11, 18, 21, 34, 48, 55, 59, 65, 69, 77.

INSTREAM PRACTICES

Grade Control Measures



Rock, wood, earth, and other material structures placed across the channel and anchored in the streambanks to provide a "hard point" in the streambed that resists the erosion forces of the degradational zone, and/or to reduce the upstream energy slope to prevent bed scour.

Applications and Effectiveness

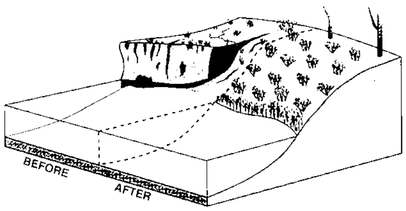
- If a stable channel bed is essential to the design, grade control should be considered as a first step before any restoration measures are implemented (if degradational processes exist in channel system).
- Used to stop headcutting in degrading channels.
- Used to build bed of incised stream to higher elevation.
- Can improve bank stability in an incised channel by reducing bank heights.
- Man-made scour holes downstream of structures can provide improved aquatic habitat.
- Upstream pool areas created by structures provide increased low water depths for aquatic habitat.
- Potential to become low flow migration barrier.
- Can be designed to allow fish passage.
- If significant filling occurs upstream of structure, then downstream channel degradation may result.
- Upstream sediment deposition may cause increased meandering tendencies.
- Siting of structures is critical component of design process, including soil mechanics and geotechnical engineering.
- Design of grade control structures should be accomplished by an experienced river engineer.

For More Information

Consult the following references: Nos. 1, 4, 5, 6, 7, 12, 17, 18, 25, 26, 31, 37, 40, 63, 66, 84.

STREAMBANK TREATMENT

Bank Shaping and Planting



Regrading streambanks to a stable slope, placing topsoil and other materials needed for sustaining plant growth, and selecting, installing and establishing appropriate plant species.

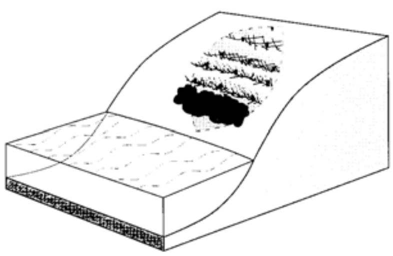
Applications and Effectiveness

- Most successful on streambanks where moderate erosion and channel migration are anticipated.
- Reinforcement at the toe of the eiribankmeiit is often needed.
- Enhances conditions for colonization of native species.
- Used in conjunction with other protective practices where flow velocities exceed the tolerance range for available plants, and where erosion occurs below base flows.
- Streambank soil materials, probable groundwater fluctuation, and bank loading conditions are factors for determining appropriate slope conditions.
- Slope stability analyses are recommended.

For More Information

Consult the following references: Nos. 11, 14, 56, 61, 65, 67, 68, 77, 79.

Branch Packing



Alternate layers of live branches and compacted backfill which stabilize and revegetate slumps and holes in streambanks.

Applications and Effectiveness

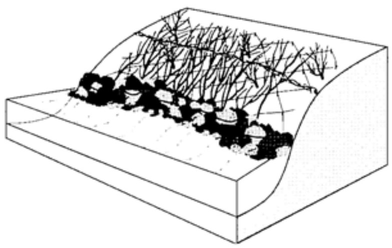
- Commonly used where patches of streambank have been scoured out or have slumped leaving a void.
- Appropriate after stresses causing the slump have been removed.
- Less commonly used on eroded slopes where excavation is required to install the branches.
- Produces a filter barrier that prevents erosion and scouring from streambank or overbank flows.
- Rapidly establishes a vegetated streambank.
- Enhances conditions for colonization of native species.
- Provides immediate soil reinforcement.
- Live branches serve as tensile inclusions for reinforcement once installed.
- Typically not effective in slump areas greater than four feet deep or four feet wide.

For More Information

Consult the following references: Nos. 14, 21, 34, 79, 81.

STREAMBANK TREATMENT

Brush Mattresses



Combination of live stakes, live facines, and branch cuttings installed to cover and physically protect streambanks; eventually to sprout and establish numerous individual plants.

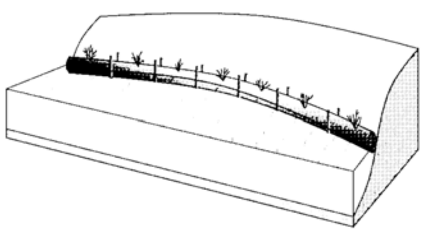
Applications and Effectiveness

- Form an immediate protective cover over the streambank.
- Capture sediment during flood flows.
- Provide opportunities for rooting of the cuttings over the streambank.
- Rapidly restores riparian vegetation and streamside habitat.
- Enhance conditions for colonization of native vegetation.
- Limited to the slope above base flow levels.
- Toe protection is required where toe scour is anticipated.
- Appropriate where exposed streambanks are threatened by high flows prior to vegetation establishment.
- Should not be used on slopes which are experiencing mass movement or other slope instability.

For More Information

Consult the following references: Nos. 14, 21, 34, 56, 65, 77, 79, 81.

Coconut Fiber Roll



Cylindrical structures composed of coconut husk fibers bound together with twine woven from coconut material to protect slopes from erosion while trapping sediment which encourages plant growth within the fiber roll.

Applications and Effectiveness

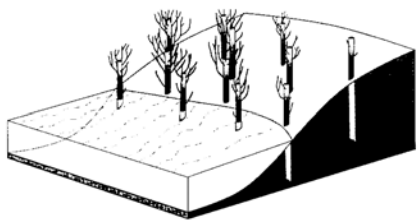
- Most commonly available in 12 inch diameter by 20 foot lengths.
- Typically staked near the toe of the streambank with dorinant cuttings and rooted plants inserted into slits cut into the rolls.
- Appropriate where moderate toe stabilization is required in conjunction with restoration of the streambank and the sensitivity of- the site allows for only minor disturbance.
- Provide an excellent medium for promoting plant growth at the water's edge.
- Not appropriate for sites with high velocity flows or large ice build up.
- Flexibility for molding to the existing curvature of the streambank.
- Requires little site disturbance.
- The rolls are buoyant and require secure anchoring.
- Can be expensive.
- An effective life of 6 to 10 years.
- Should, where appropriate, be used with soil bioengineering systems and vegetative plantings to stabilize the upper bank and ensure a regenerative source of streamside vegetation.
- Enhances conditions for colonization of native vegetation.

For More Information

Consult the following references: Nos. 65, 77.

STREAMBANK TREATMENT

Dormant Post Plantings



Plantings of cottonwood, willow, poplar, or other species embedded vertically into streambanks to increase channel roughness, reduce flow velocities near the slope face, and trap sediment.

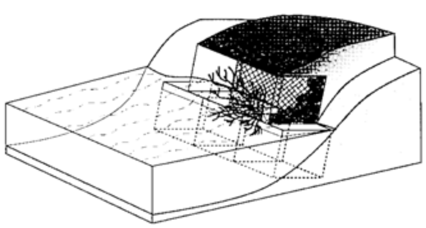
Applications and Effectiveness

- Can be used as live piling to stabilize rotational failures on streambanks where minor bank sloughing is occurring.
- Useful for quickly establishing riparian vegetation, especially in and regions where water tables are deep.
- Will reduce near bank stream velocities and cause sediment deposition in treated areas.
- Reduce streambank erosion by decreasing the near-bank flow velocities.
- Generally self-repairing and will restem if attacked by beaver or livestock; however, provisions should be made to exclude such herbivores where possible.
- Best suited to non-gravely streams where ice damage is not a problem.
- Will enhance conditions for colonization of native species.
- Are less likely to be removed by erosion than live stakes or smaller cuttings.
- Should, where appropriate, be used with soil bioengineering systems and vegetative plantings to stabilize the upper bank and ensure a regenerative source of streamside vegetation.
- Unlike smaller cuttings, post harvesting can be very destructive to the donor stand, therefore, they should be gathered as 'salvage' from sites designated for clearing, or thinned from dense stands.

For More Information

Consult the following references: Nos. 65, 77, 79.

Vegetated Gabions



Wire-mesh, rectangular baskets filled with small to medium size rock and soil and laced together to form a structural toe or sidewall. Live branch cuttings are placed on each consecutive layer between the rock filled baskets to take root, consolidate the structure, and bind it to the slope.

Applications and Effectiveness

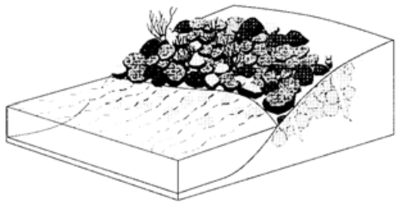
- Useful for protecting steep slopes where scouring or undercutting is occurring or there are heavy loading conditions.
- Can be a cost effective solution where some form of structural solution is needed and other materials are not readily available or must be brought in from distant sources.
- Useful when design requires rock size greater than what is locally available.
- Effective where bank slope is steep and requires moderate structural support.
- Appropriate at the base of a slope where a low toe wall is needed to stabilize the slope and reduce slope steepness.
- Will not resist large, lateral earth stresses.
- Should, where appropriate, be used with soil bioengineering systems and vegetative plantings to stabilize the upper bank and ensure a regenerative source of streambank vegetation.
- Require a stable foundation.
- Are expensive to install and replace.
- Appropriate where channel side slopes must be steeper than appropriate for riprap or other material, or where channel toe protection is needed, but rock riprap of the desired size is not readily available.
- Are available in vinyl coated wire as well as galvanized steel to improve durability.
- Not appropriate in heavy bedload streams or those with severe ice action because of serious abrasion damage potential.

For More Information

Consult the following references: Nos. 11, 18, 34, 56, 77.

STREAMBANK TREATMENT

Joint Plantings



Live stakes tamped into joints or openings between rock which have previously been installed on a slope or while rock is being placed on the slope face.

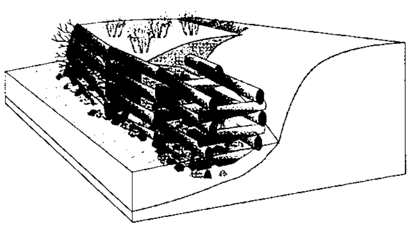
Applications and Effectiveness

- Appropriate where there is a lack of desired vegetative cover on the face of existing or required rock riprap.
- Root systems provide a mat upon which the rock riprap rests and prevents loss of fines from the underlying soil base.
- Root systems also improve drainage in the soil base.
- Will quickly establish riparian vegetation.
- Should, where appropriate, be used with other soil bioengineering systems and vegetative plantings to stabilize the upper bank and ensure a regenerative source of streambank vegetation.
- Have few limitations and can be installed from base flow levels to top of slope, if live stakes are installed to reach ground water.
- Survival rates can be low due to damage to the cambium or lack of soil/stake interface.
- Thick rock riprap layers may require special tools for establishing pilot holes.

For More Information

Consult the following references: Nos. 21, 34, 65, 77, 81.

Live Cribwalls



Hollow, box-like interlocking arrangements of untreated log or timber members filled above baseflow with alternate layers of soil material and live branch cuttings that root and gradually take over the structural functions of the wood members.

Applications and Effectiveness

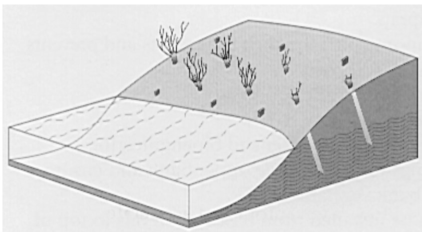
- Provide protection to the streambank in areas with near vertical banks where bank sloping options are limited.
- Afford a natural appearance, immediate protection and accelerate the establishment of woody species.
- Effective on outside of bends of streams where high velocities are present.
- Appropriate at the base of a slope where a low wall might be required to stabilize the toe and reduce slope steepness.
- Appropriate above and below water level where stable streambeds exist.
- Don't adjust to toe scour.
- Can be complex and expensive.
- Should, where appropriate, be used with soil bioengineering systems and vegetative plantings to stabilize the upper bank and ensure a regenerative source of streambank vegetation.

For More Information

Consult the following references: Nos. 11, 14, 21, 34, 56, 65, 77, 81.

STREAMBANK TREATMENT

Live Stakes



Live, woody cuttings which are tamped into the soil to root, grow and create a living root mat that stabilizes the soil by reinforcing and binding soil particles together, and by extracting excess soil moisture.

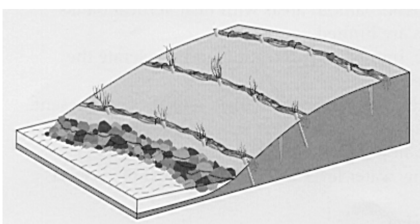
Applications and Effectiveness

- Effective where site conditions are uncomplicated, construction time is limited, and an inexpensive method is needed.
- Appropriate for repair of small earth slips and slumps that are frequently wet.
- Can be used to stake down surface erosion control materials.
- Stabilize intervening areas between other soil bioengineering techniques.
- Rapidly restores riparian vegetation and streamside habitat.
- Should, where appropriate, be used with other soil bioengineering systems and vegetative plantings.
- Enhance conditions for colonization of vegetation from the surrounding plant community.
- Requires toe protection where toe scour is anticipated.

For More Information

Consult the following references: Nos. 14, 21, 34, 56, 65, 67, 77, 79, 81.

Live Fascines



Dormant branch cuttings bound together into long sausage-like, cylindrical bundles and placed in shallow trenches on slopes to reduce erosion and shallow sliding.

Applications and Effectiveness

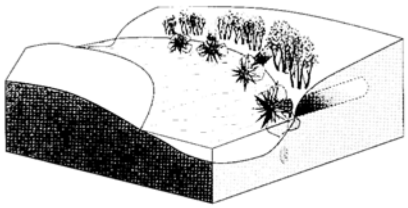
- Can trap and hold soil on streambank by creating small dam-like structures and reducing the slope length into a series of shorter slopes.
- Facilitate drainage when installed at an angle on the slope.
- Enhance conditions for colonization of native vegetation.
- Should, where appropriate, be used with other soil bioengineering systems and vegetative plantings.
- Requires toe protection where toe scour is anticipated.
- Effective stabilization technique for streambanks, requiring a minimum amount of site disturbance.
- Not appropriate for treatment of slopes undergoing mass movement.

For More Information

Consult the following references: Nos. 14, 21, 34, 65, 77, 81.

STREAMBANK TREATMENT

Log,Rootwad,and Boulder Revetments



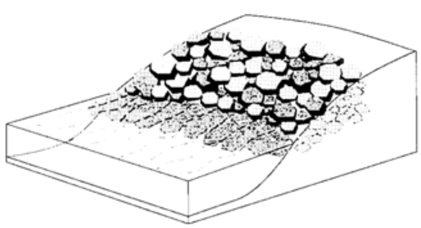
Boulders and logs with root masses attached placed in and on streambanks to provide streambank erosion, trap sediment, and improve habitat diversity.

Applications and Effectiveness
Applications and Effectiveness

- Will tolerate high boundary shear stress if logs and rootwads are well anchored.
- Suited to streams where fish habitat deficiencies exist.
- Should, where appropriate, be used with soil bioengineering systems and vegetative plantings to stabilize the upper bank and ensure a regenerative source of streambank vegetation.
- Will enhance diversity in riparian areas when used with soil bioengineering systems.
- Will have limited life depending on climate and tree species used. Some species, such as cottonwood or willow, often sprout and accelerate colonization.
- Might need eventual replacement if colonization does not take place or soil bioengineering systems are not used.
- Use of native materials can sequester sediment and woody debris, restore streambanks in high velocity streams, and improve fish rearing and spawning habitat.
- Site must be accessible to heavy equipment.
- Materials might not be readily available at some locations.
- Can create local scour and erosion.
- Can be expensive.

For More Information
Consult the following references: Nos. 11, 34, 77.

Riprap



A blanket of appropriately sized stones extending from the toe of slope to a height needed for long term durability.

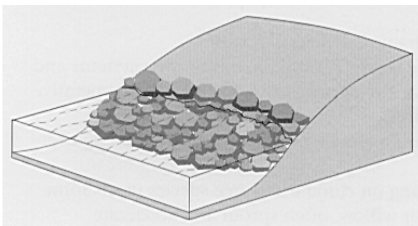
Applications and Effectiveness

- Can be vegetated (see joint plantings).
- Appropriate where long term durability is needed, design discharge are high, there is a significant threat to life or high value property, or there is no practical way to otherwise incorporate vegetation into the design.
- Should, where appropriate, be used with soil bioengineering systems and vegetative plantings to stabilize the upper bank and ensure a regenerative source of streambank vegetation.
- Flexible and not impaired by slight movement from settlement or other adjustments.
- Should not be placed to an elevation above which vegetative or soil bioengineering systems are an appropriate alternative.
- Commonly used form of bank protection.
- Can be expensive if materials are not locally available.

For More Information
Consult the following references: Nos. 11, 14, 18, 34, 39, 56, 67, 70, 77.

STREAMBANK TREATMENT

Stone Toe Protection



A ridge of quarried rock or stream cobble placed at the toe of the streambank as an armor to deflect flow from the bank, stabilize the slope and promote sediment deposition.

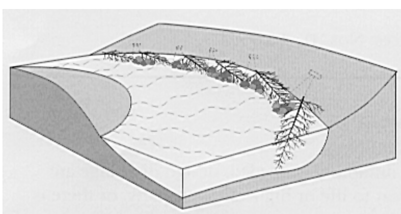
Applications and Effectiveness

- Should be used on streams where banks are being undermined by toe scour, and where vegetation cannot be used.
- Stone prevents removal of the failed streambank material that collects at the toe, allows revegetation and stabilizes the streambank.
- Should, where appropriate, be used with soil bioengineering systems and vegetative plantings to stabilize the upper bank and ensure a regenerated source of streamside vegetation.
- Can be placed with minimal disturbance to existing slope, habitat, and vegetation.

For More Information

Consult the following references: Nos. 10, 21, 56, 67, 77, 81.

Tree Revetments



A row of interconnected trees attached to the toe of the streambank or to deadmen in the streambank to reduce flow velocities along eroding streambanks, trap sediment, and provide a substrate for plant establishment and erosion control.

Applications and Effectiveness

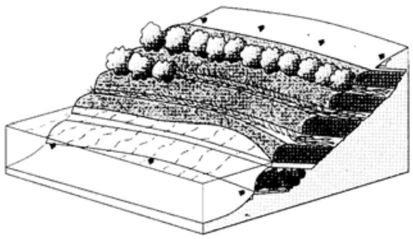
- Design of adequate anchoring systems is necessary.
- Wire anchoring systems can present safety hazards.
- Work best on streams with streambank heights under 12 feet and bankfull velocities under 6 feet per second.
- Use inexpensive, readily available materials.
- Capture sediment and enhances conditions for colonization of native species particularly on streams with high bed material loads.
- Limited life and must be replaced periodically.
- Might be severely damaged by ice flows.
- Not appropriate for installation directly upstream of bridges and other channel constrictions because of the potential for downstream damages should the revetment dislodge.
- Should not be used if they occupy more than 15 percent of the channel's cross sectional area at bankfull level.
- Not recommended if debris jams on downstream bridges might cause subsequent problems.
- Species that are resistant to decay are best because they extend the establishment period for planted or volunteer species that succeed them.
- Requires toe protection where toe scour is anticipated.
- Should, where appropriate, be used with soil bioengineering systems and vegetative plantings to stabilize the upper bank and ensure a regenerated source of streamside vegetation.

For More Information

Consult the following references: Nos. 11, 21, 34, 56, 60, 77, 79.

STREAMBANK TREATMENT

Vegetated Geogrids



Alternating layers of live branch cuttings and compacted soil with natural or synthetic geotextile materials wrapped around each soil lift to rebuild and vegetate eroded streambanks.

Applications and Effectiveness

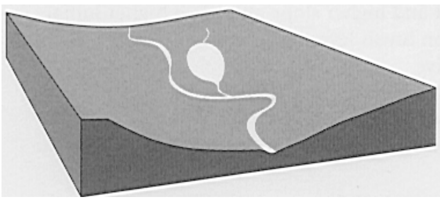
- Quickly establish riparian vegetation if properly designed and installed.
- Can be installed on a steeper and higher slope and has a higher initial tolerance of flow velocity than brush layering.
- Can be complex and expensive.
- Produce a newly constructed, well-reinforced streambank.
- Useful in restoring outside bends where erosion is a problem.
- Capture sediment and enhances conditions for colonization of native species.
- Slope stability analyses are recommended.
- Can be expensive.
- Require a stable foundation.

For More Information

Consult the following references: Nos. 10, 11, 14, 21, 34, 56, 65, 77.

WATER MANAGEMENT

Sediment Basins



Barriers, often employed in conjunction with excavated pools, constructed across a drainage way or off-stream and connected to the stream by a flow diversion channel to trap and store waterborne sediment and debris.

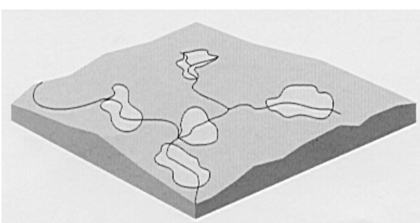
Applications and Effectiveness

- Provide an interim means of reducing the sediment load from a stream.
- Used occasionally to sort sediment sizes.
- Temporarily reduce excessive sediment loads until the upstream watershed can be protected from accelerated erosion.
- Can also be used to separate out sediment which may be causing damages downstream along reaches which are incapable of transporting the sediment sizes.
- Can be integrated with more permanent stormwater management ponds.
- Can only trap the upper range of particle sizes (sand and gravel) and allow finer particles (silt and clay) to pass through.
- Require a high level of analysis.
- Require periodic dredging and other maintenance.

For More Information

Consult the following references: Nos. 10, 13, 29, 45, 49, 69, 74, 80.

Water Level Control



Managing water levels within the channel and adjoining riparian zone to control aquatic plants and restore desired functions, including aquatic habitat.

Applications and Effectiveness

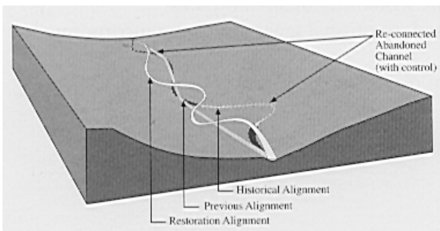
- Appropriate where flow depth in the stream, adjoining wetland, or the interdependent saturation zone in the adjoining riparian area is insufficient to provide desired functions.
- Need will often vary by season and requires flexible control devices which can be managed accordingly.
- The complexities of maintaining sediment balances, temperature elevation, change in channel substrate, changes in flow regime, and a host of other considerations must be factored into planning and design.
- Requires a high level of analysis.

For More Information

Consult the following references: Nos. 11, 13, 15, 69, 75.

CHANNEL RECONSTRUCTION

Maintenance of Hydraulic Connections



Maintenance of hydraulic connectivity to allow movement of water and biota between the stream and abandoned channel reaches.

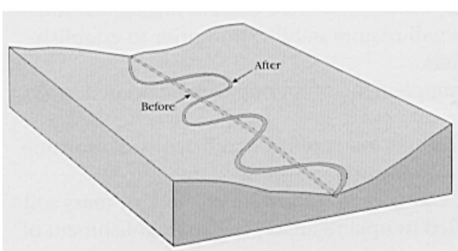
Applications and Effectiveness
Applications and Effectiveness

- Used to prevent losses of aquatic habitat area and diversity.
- Slackwater areas adjoining the main channel have potential for spawning and rearing areas for many fish species and are a key component of habitat for wildlife species that live in or migrate through the riparian corridor.
- Recreation value can be enhanced if connecting channels are deep enough for small boats or canoes.
- Effective along reaches of realigned channel where cutoffs have been made.
- Not effective in streams with insufficient stages or discharges to maintain satisfactory hydraulic connections to the abandoned channel reaches.
- May require maintenance if sedimentation is a problem.
- May have limited life.
- Require a high level of analysis.

For More Information

Consult the following references: Nos. 15, 56, 69, 75.

Stream Meander Restoration



Transformation of a straightened stream into a meandering one to reintroduce natural dynamics improve channel stability, habitat quality, aesthetics, and other stream corridor functions or values.

Applications and Effectiveness

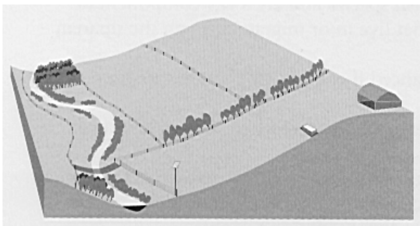
- Used to create a more stable stream with more habitat diversity.
- Requires adequate area where adjacent land uses may constrain locations.
- May not be feasible in watersheds experiencing rapid changes in land uses.
- Streambank protection might be required on the outside of bends.
- Significant risk of failure.
- Requires a high level of analysis.
- May cause significant increases in flood elevations.
- Effective discharge should be computed for both existing and future conditions, particularly in urbanized watersheds.

For More Information

Consult the following references: Nos. 13, 16, 22, 23, 24, 46, 47, 52, 53, 54, 56, 61, 72, 75, 77, 78, 79, 86.

STREAM CORRIDOR MEASURES

Livestock Exclusion or Management



Fencing, alternate sources of water and shelter, and managed grazing to protect, maintain, or improve riparian flora and fauna and water quality.

Applications and Effectiveness

- Appropriate where livestock grazing is negatively impacting the stream corridor by reducing growth of woody vegetation, decreasing water quality, or contributing to the instability of streambanks.

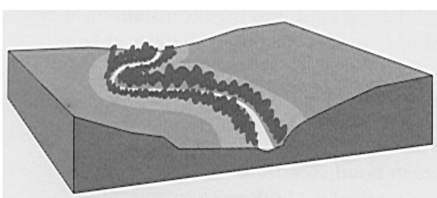
Applications and Effectiveness

- Once the system has recovered, rotational grazing may be incorporated into the management plan.
- Must be coordinated with an overall grazing plan.

For More Information

Consult the following references: Nos. 18, 39, 73.

Riparian Forest Buffers



Streamside vegetation to lower water temperatures, provide a source of detritus and large woody debris, improve habitat, and to reduce sediment, organic material, nutrients, pesticides and other pollutants migrating to the stream.

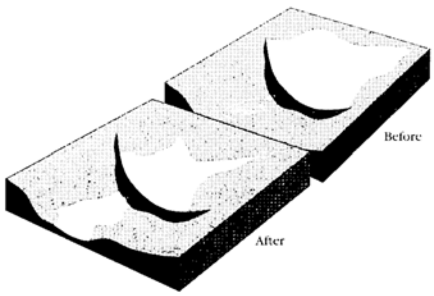
Applications and Effectiveness

- Applicable on stable areas adjacent to permanent or intermittent streams, lakes, ponds, wetlands and areas with ground water recharge.
- Unstable areas such as those with high surface erosion rates, mass soil movement, or active gullies will require stabilization prior to establishment of riparian forest buffers.
- Tolerant plant species and supplemental watering may be needed in some areas.
- Sites in arid and semi-arid regions may not have sufficient soil moisture throughout the growing season to support woody plants.
- Concentrated flow erosion, excessive sheet and rill erosion, or mass soil movement must be controlled in upland areas prior to establishment of riparian forest buffers.

For More Information

Consult the following references: Nos. 20, 34, 49, 51, 70, 78, 79, 81, 82, 88, 89.

Flushing for Habitat Restoration



A high-magnitude, short duration release from a reservoir to scour fine-grained sediments from the streambed and restore suitable instream habitat.

Applications and Effectiveness

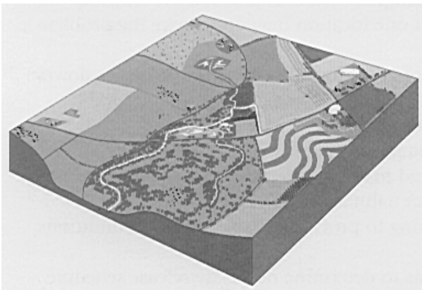
- Appropriate as part of an overall watershed management plan.
- May cause flooding of old floodplains below dams, depletion of gravel substrates, and significant changes in channel geometry.
- Flushing of fine sediments at one location may only move the problem further downstream.
- Seasonal discharge limits, rate of change of flow, and river stages downstream of impoundment should be considered to avoid undesirable impacts to instream and riparian habitat.
- Can be effective in improving gradation of streambed materials, suppression of aquatic vegetation, and maintenance of stream channel geometry necessary for desired instream habitat.
- Can induce floodplain scouring to provide suitable growing conditions for riparian vegetation.
- Requires high level of analysis to determine necessary release schedule.
- May not be feasible in areas where water rights are fully allocated.

For More Information

Consult the following references: Nos. 11, 13, 32, 35, 41, 45, 57, 61, 73, 74, 81.

WATERSHED MANAGEMENT

Best Management Practices: Agriculture



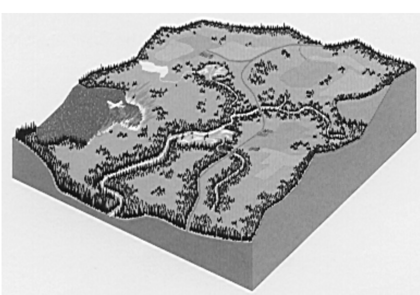
Individual and systematic approaches aimed at mitigating non-point source pollution from agricultural land.

Applications and Effectiveness
Applications and Effectiveness

- Used where current management systems are causing problems on-site or within farm or field boundaries and have a high potential to impact the stream corridor.
- Also applied where watershed management plans are being implemented to improve environmental conditions.
- Must fit within a comprehensive farm management plan, a watershed action plan, or a stream corridor restoration plan.
- Should consider the four-season conservation of the soil, water, and microbial resources base.
- Tillage, seeding, fertility, pest management, and harvest operations should consider environmental qualities and the potential to use adjacent lands in water and soil conservation and management and pest management.
- Grazing land management should protect environmental attributes, including native species protection, while achieving optimum, long-term resource use.
- Where crops are raised and the land class allows, pastures should be managed with crop rotation sequences to provide vigorous forage cover while building soil and protecting water and wildlife qualities.
- Orchards and nursery production should actively monitor pest and water management techniques to protect ecosystem quality and diversity.
- Farm woodlots, wetlands, and field borders should be part of an overall farm plan that conserves, protects, and enhances native plants and animals, soil, water, and scenic qualities.
- BMPs may include: contour farming, conservation tillage, terracing, critical area planting, nutrient management, sediment basins, filter strips, waste storage management, and integrated pest management.

For More Information
Consult the following references: Nos. 73, 78, 81.

Best Management Practices: Forestland



Individual and systematic approaches for mitigating non-point source pollution from forestland.

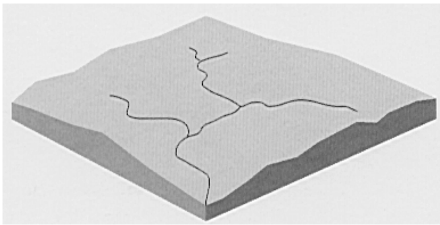
Applications and Effectiveness

- Used where current management systems are causing problems in the watershed and have a high potential to impact the stream corridor. • Also applied where management plans are being implemented to restore one or more natural resource functions in a watershed.
- Must consider how it fits within a comprehensive forestland management plan, a watershed action plan, or a stream corridor restoration plan.
- BMPs may include: preharvest planning, streamside management measures, road construction or reconstruction, road management, timber harvesting, site preparation and forest generation, fire management, revegetation of disturbed areas, forest chemical management, and forest wetland management.

For More Information
Consult the following references: Nos. 9, 20, 27, 30, 34, 42, 49, 51, 70, 78, 79, 81, 82, 83, 88, 89.

WATERSHED MANAGEMENT

Flow Regime Enhancement



Manipulation of watershed features (such as changes in land use or construction of impoundments) for the purpose of controlling streamflow and improving physical, chemical and biological functions.

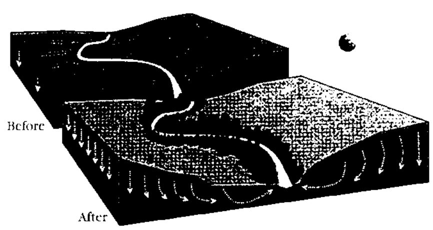
Applications and Effectiveness

- Appropriate where human-induced changes have altered stream flow characteristics to the extent that streams no longer support their former functions.
- Can restore or improve threatened functions (e.g., substrate materials or distribution of flow velocities to support the natural food web).
- Can require extensive changes over broad areas involving many land users.
- Can be expensive.
- Has been used for remediation of depleted dissolved oxygen levels, reduction in salinity levels, or to maintain a minimum flow level for downstream users.
- Must determine what impacts from historical changes in the flow regime over time can be mitigated using flow enhancement techniques.

For More Information

Consult the following references: Nos. 32, 39, 45, 57, 75, 81.

Streamflow Temperature Management



Streamside vegetation and upland practices to reduce elevated streamflow temperatures.

Applications and Effectiveness

- Effective for smaller streams where bank vegetation can provide substantial shading of the channel and on which much of the canopy has been removed.
- Appropriate practices are those that establish streamside vegetation, increase vegetative cover, increase infiltration and subsurface flow, maintain base flow, and reduce erosion.
- Turbid water absorbs more solar radiation than clear; therefore, erosion control in watersheds can help in reducing thermal pollution.
- Flow releases from cooler strata of reservoirs must be exercised with caution. Although cooler, water from this source is generally low in dissolved oxygen and must be aerated before discharging downstream. Selective mixing of the reservoir withdrawal can moderate temperature as may be required.
- There might be opportunities in irrigated areas to cool return flows prior to discharge to streams.

For More Information

Consult the following references: Nos. 32, 39, 45, 73, 80, 81, 88, 89.

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